

FLOW OF LIQUID FUEL  
THROUGH ORIFICES

BY  
MILTON MARKS  
H. P. CLAUSEN  
Y. M. WONG

ARMOUR INSTITUTE OF TECHNOLOGY

1920

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An investigation of the flow  
of liquid fuel through

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# AN INVESTIGATION OF THE FLOW OF LIQUID FUEL THROUGH ORIFICES

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A THESIS

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PRESENTED BY

MILTON MARKS, HAROLD F. CLAUSEN AND YAK M. WONG

TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

BACHELOR OF SCIENCE

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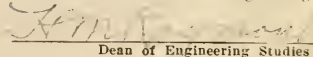
MECHANICAL ENGINEERING

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MAY 27, 1920

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Professor of Mechanical Engineering

  
Dean of Engineering Studies

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**PART 1.**

**Object,**

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• 1700

## AN INVESTIGATION OF THE FLOW OF LIQUID FUEL THROUGH ORIFICES.

The object of this thesis is the investigation of the flow of liquid fuel through orifices.

The fuel used throughout the investigation was kerosine oil. No attempts were made to conduct any test with any other oils, although the apparatus used and the system of calculation can easily be applied to any other fuel, such as alcohol, gasoline, agni-benzol or others.

In the testing of engines it is very desirable to know just how much fuel it is burning at any instant. At present the general method of determining fuel consumption in an engine is to measure the time and determine the weight of fuel used during that time, or to measure the fuel and determine the time. In either case there is much chance for error



because the running conditions may vary during the course of the run. An indicating device which would register any instantaneous change in flow would be the solution of the problem. With this perfected the cause of variation could be discovered and the best running conditions of the engine could be determined. An instrument of this kind would, therefore, be of much value.

With this idea in view, an attempt was made to build and calibrate an instrument or metering device which would register the required readings. A flow meter, the front elevation of which is shown in Fig.I. was the instrument constructed.





**PART 11.**

**Apparatus.**



The apparatus is as follows:- a 5 gallon tank of kerosine which has a pipe leading from its lower end into a carburetor D, Fig.I., 2 feet below. The float in D maintains the oil at a constant level so that the flow into the apparatus always is under one constant head. From here the oil flows through the pipe N, and through the orifices A and B into the carburetor E. From here the oil flows through the orifice C and out into a measuring glass.

The center line of the horizontal pipe leading to the carburetor E is 2.3 inches above the center line of the outlet pipe which holds the orifice C.

The so called orifices are standard petcocks. They have the regular opening and closing levers, and can be opened full amount or any fraction thereof. Flat pieces of brass were fastened under the control handle, and ordinary protractors were soldered onto these brass plates. The plan view of the apparatus



as shown Fig.II., shows how the protractors were connected.

An indicating pointer was attached to handle of the valve or orifice. By means of this pointer and protractor the opening and closing position of the orifice was determined. This was done by allowing the fuel to flow through the system. With two valves open the third handle was turned along the indicator until no fuel flowed out of C. This point was then marked as the closing position of orifice. The indicator showed the angle on protractor at this point.

The positions or angles of the opening and closing are given as follows for each orifice:-

	A	B	C
Closed at	47 deg.	138 deg.	127deg.
Opened 1 deg. at	46 deg.	139 deg.	126deg.

This means that when the indicator is over the angle indicated in the first row, the orifice A, B or C is just the closed position.



The second row shows the indicator position when the orifice is one degree open.

Fig.III. shows a section through the carburetors used in this apparatus. They are standard pieces, and can be replaced at any time. The fuel enters through the pipe at the lower right hand side, raises in tube F, and leaves at the lower left. These carburetors maintain a constant level of the fuel.

The center line through the pipe C was called the zero line. About 8 inches up from this line and leading out from the pipe N at right angles is a brass tube. Attached to this tube is one of glass which turns at right angles and goes straight up. This glass tube shows at all times what the level of the fuel is in the carburetor D. This also shows the head on the system at all times. It should be and is constant throughout all runs.

Half way between the two orifices A and B is a tube which leads up. About four inches up on this tube another tube leads off at right





angles. These tubes show at any instant what the head is above orifice B. Either the column F or G will show at any instant what this head is in inches of the fuel used in the test. The tube F is bent at an angle at top so that more accurate readings can be taken. When the column falls below the 19 inch line, the column G is read instead of F. This gives the same readings as column F.

Another tube is set up in the line between the carburetor E and the orifice C. This tube represents the head in the line just after the carburetor E and is called column H.

The whole apparatus is mounted on a wooden frame.

Utilizing the center line of C as a zero line, there is a scale graduated in inches set up on the frame under the column H, G, I and F. By means of this scale the heights of the fuel in these various columns can be read, and, therefore, the heads at any instant can be read at the various points in the line.



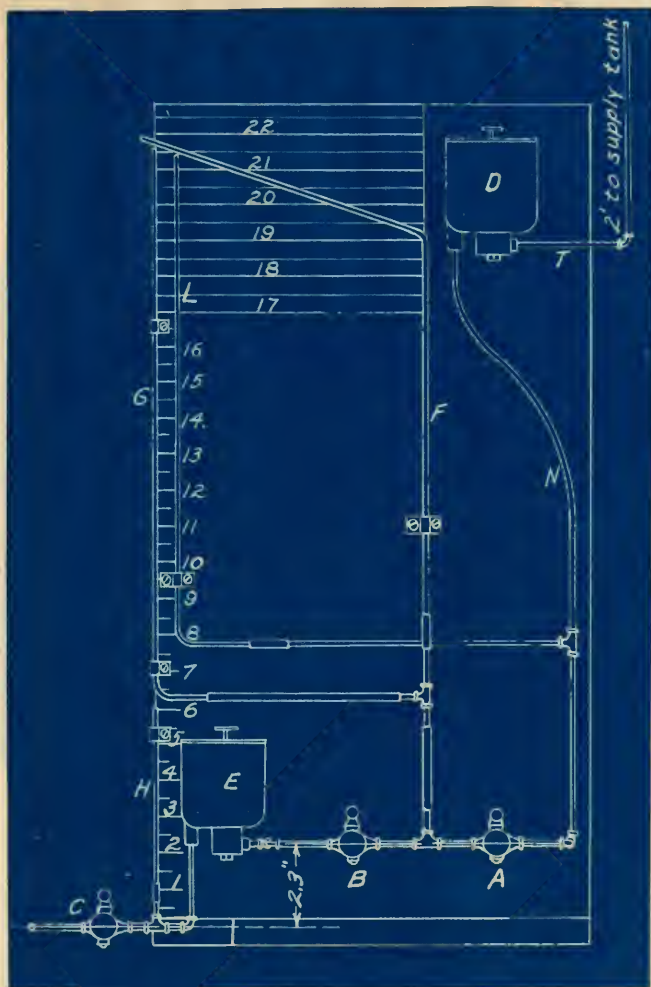
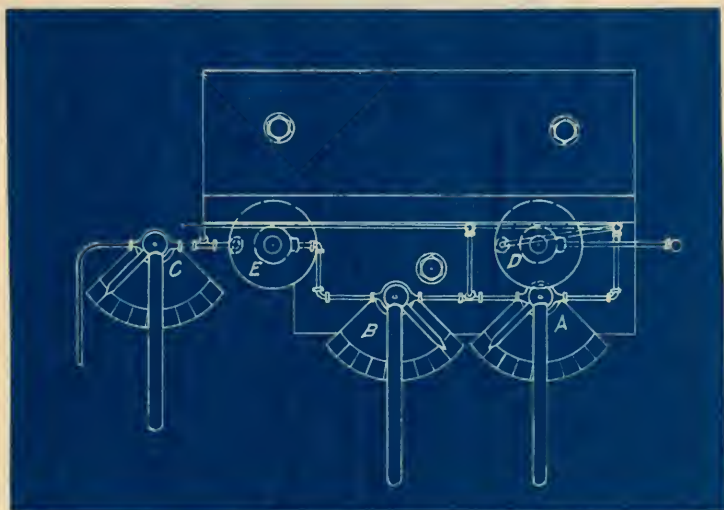


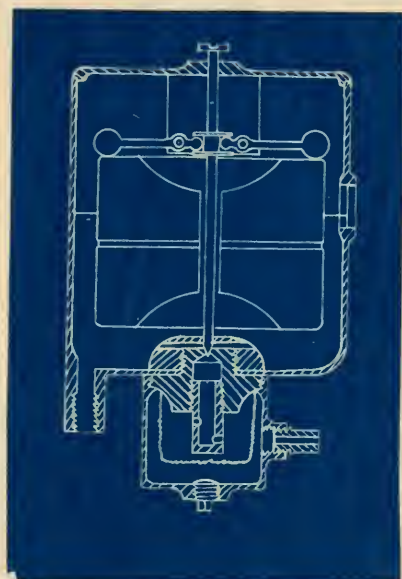
Fig.1,





**Fig. 11.**





**Fig. 111.**

• 477 - 478



PART III.

Procedure.



The first step in conducting the test of this instrument was to determine the closing position of the orifices. The method of doing this was described in Part I. under apparatus. It was found that the largest opening of orifice A is 47 degrees. For orifice B it was found to be 36 degrees. For orifice C it was found to be 32 degrees. This means that these are the number of degrees on the protractor indicated by the pointer between the largest opening position and closing position for each orifice.

Runs were made with the orifices opened to various degrees on the protractors. The first test was made with the orifice A opened 47 degrees and B opened 36 degrees. The opening of orifice C was varied by four degree increments from the closed position to the position of the largest opening. This gives nine separate runs. The runs were of two minute duration and the fuel was measured in cubic centimeters at the end of each run.

When this test was completed, runs were



made with A open 47 degrees and B open 32 degrees. The next test was made with A open 47 degrees and B open 28 degrees. This was continued until B was closed. A was then closed to 43 degrees and the same process was gone through. During each separate run the orifice C was varied four degrees, from 32 degrees open to closed. In these tests there were 12 different positions of the orifice A, 9 positions of the orifice B, for every position of A, and 8 positions of orifice for every position of B. This totals up to  $8 \times 9 \times 12$  or 864 runs.

The readings taken for each run were as follows:-

Degrees opening of A.

Degrees opening of B.

Degrees opening of C.

Height of column F or G.

Height of column L.

Height of column H.



Number of cubic centimeters of fuel which flowed through the orifice.

The temperature of the oil.

A Baumé reading was taken the first day that runs were made, and the specific gravity calculated for each run.





PART IV.

Calculations.



The following formula was used to calculate the specific gravity of the oil for the various temperatures.

$$\text{Specific gravity} = \frac{141.5}{131.5 + \text{deg. Baumé}}$$

60 degrees Fahrenheit, standard.

Degrees Baumé vary one degree Baumé for every ten degrees Fahrenheit change in temperature.

Example:

At 71.5 degrees Fahrenheit the Baumé was 43.2 degrees.

$$\begin{aligned} \text{Sp. gr. at 71.5 deg. Fahr.} &= \frac{141.5}{131.5 + 43.2} \\ &= .80996 \end{aligned}$$

At 60 degrees Fahrenheit the Baumé

$$\text{reading is 43.2} = \frac{71.5 - 60}{10} = 42.05$$

$$\text{The sp.gr. is } \frac{141.5}{131.5 + 42.05} = .81562$$

The first part of the paper is devoted to the study of the properties of the function  $f(x)$  defined by the equation

$$f(x) = \frac{1}{x} \int_0^x f(t) dt$$

It is shown that  $f(x)$  is a constant function. The second part of the paper is devoted to the study of the properties of the function  $g(x)$  defined by the equation

$$g(x) = \frac{1}{x} \int_0^x g(t) dt$$

It is shown that  $g(x)$  is a constant function. The third part of the paper is devoted to the study of the properties of the function  $h(x)$  defined by the equation

$$h(x) = \frac{1}{x} \int_0^x h(t) dt$$

It is shown that  $h(x)$  is a constant function. The fourth part of the paper is devoted to the study of the properties of the function  $k(x)$  defined by the equation

$$k(x) = \frac{1}{x} \int_0^x k(t) dt$$

To calculate the pounds of kerosene per hour, the following method was used.

$$\text{Lb./hr.} = \frac{\text{sp.gr.} \times .002203 \times \text{C.C.} \times 60}{T}$$

.002203 = the weight, in pounds of one C.C. of water.

C.C. = the cubic centimeters of kerosene which flowed in the time T.

T = the time of flow in minutes.

For two minute runs the formula reduces

$$\text{to:- Lb./hr.} = \frac{\text{sp.gr.} \times .002203 \times \text{C.C.} \times 60}{2}$$

$$= 0.06609 \times \text{C.C.} \times \text{sp. gr.}$$

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PART V.

**An Automatic Weighing and Recording Device.**

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The large figure in the back cover shows a very accurate and convenient apparatus for weighing a definite amount of fuel; the watch shown, automatically recording the time of flow. This apparatus was built in the electrical laboratory of Armour Institute, and operates as follows:-

Running, no testing.

Switch to Right.

As gasoline is used, tank gets lighter and rises- this makes rear contact and opens supply valve. Tank will fill until it drops and breaks contact. This stops gasoline supply. The tank now gets lighter as gasoline is being used- then operation repeats.

Testing.

Switch to Left.

Now supply valve always remains closed. As fuel is used, tank gets lighter and raises- this makes front contact and starts the watch. Move the switch to the off position. Put one-half pound weight under tank- put switch on



testing position (to left again). The tank will now rise when the one-half pound of gasoline has been used. This makes front contact the second time and stops the watch. Take the reading and turn the switch to the right and remove the one-half pound test weight.



## PART VI.

### Data and Curves.



Figures 1 to 12 are drawn with  $H$  constant for each curve.

With a given opening of valves  $A$ ,  $B$  and  $C$ , the height of column  $F$  can be found by referring to proper curve.

Example.

Given  $C = 20$  deg. open.

"  $A = 43$  deg. "

"  $B = 28$  deg. "

From Fig. 2., curve III.  $F$  is found to be 19.7 inches.

Figures 13 to 24 are drawn with  $H$  constant for each curve.

Knowing the position of valves  $A$  and  $B$  and the height of column  $F$ , we can go to curves 13 to 24 and determine the pounds oil flowing per hour.

Example.

Given  $F = 20$  inches.

"  $A = 43$  degrees open.

"  $B = 28$  degrees open.

From figure 14, curve III. ,  $W$  is found

LETTER TO THE EDITOR:—The following is a list of the  
members of the American Medical Association who have  
been elected to the office of the Association for the year 1919.

- Dr. J. C. ... ..
- Dr. ... ..
- Dr. ... ..
- Dr. ... ..

THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION  
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- Dr. ... ..
- Dr. ... ..
- Dr. ... ..



that 24 pounds of kerosine flow per hour.

Figures 25 to 34 are drawn with F constant for each curve.

With a given opening of valves A and B and the height of column F, we can go to the curves and find the number of pounds of kerosine which are flowing per hour.

Example.

Given F = 19 inches.

" B = 28 deg. open.

" A = 30 deg. open.

From figure 27, curve IV., it is found that 32.5 pounds of kerosine flow per hour.

Figure 34 is drawn with B constant for each curve.

Knowing the height of column F and the position of A, and B is open 36 degrees, we can refer to the figure and find the number of pounds of fuel which flow per hour.

Example.

Given F = 24 inches.

" A = 15 deg. open.

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4	24	1000
		1000

1000

Given B = 36 deg. open.

From figure 34, curve IX., it is found that 20 pounds of kerosine flow per hour.

Figure 35 is figure 34 drawn to a larger scale. The points for F = 17 were taken directly from figure 34.



Table 1.

"A" open 47 deg. 76 deg. Fahr.  
 "B" open 36 deg. 5 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.50	0	0.00
4	20.85	20.79	4.42	108	2.33
8	20.82	20.74	4.39	301	6.50
12	20.79	20.55	4.30	535	11.54
16	20.72	20.20	4.20	893	19.25
20	20.50	19.70	3.90	1300	28.00
24	20.30	19.05	3.60	1734	37.40
28	20.05	18.30	3.20	2190	47.30
32	19.80	17.70	2.50	2520	54.40

Table 2.

"A" open 47 deg. 74 deg. Fahr.  
 "B" open 32 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.80	-----	43	2.32
8	20.80	20.66	-----	118	6.37
12	-----	20.40	4.40	214	11.54
16	-----	20.20	-----	354	19.10
20	20.52	19.65	3.95	619	28.00
24	-----	19.00	-----	702	37.90
28	-----	18.20	3.35	870	46.90
32	19.00	17.10	-----	920	49.60

# TABLE I

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction

Concentration of the solution		Rate of the reaction			Concentration of the solution
g/l	mol/l	g/l	mol/l	g/l	
10	0.001	10	0.001	10	0.001
20	0.002	20	0.002	20	0.002
30	0.003	30	0.003	30	0.003
40	0.004	40	0.004	40	0.004
50	0.005	50	0.005	50	0.005
60	0.006	60	0.006	60	0.006
70	0.007	70	0.007	70	0.007
80	0.008	80	0.008	80	0.008
90	0.009	90	0.009	90	0.009
100	0.010	100	0.010	100	0.010

# TABLE II

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction

Concentration of the solution		Rate of the reaction			Concentration of the solution
g/l	mol/l	g/l	mol/l	g/l	
10	0.001	10	0.001	10	0.001
20	0.002	20	0.002	20	0.002
30	0.003	30	0.003	30	0.003
40	0.004	40	0.004	40	0.004
50	0.005	50	0.005	50	0.005
60	0.006	60	0.006	60	0.006
70	0.007	70	0.007	70	0.007
80	0.008	80	0.008	80	0.008
90	0.009	90	0.009	90	0.009
100	0.010	100	0.010	100	0.010

Table 3.

"A" open 47 deg. 74 deg. Fahr.  
 "B" open 28 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	29.90	29.90	4.70	0	0.00
4	-----	20.79	-----	42	2.26
8	-----	20.70	-----	125	6.75
12	-----	20.48	-----	214	11.54
16	20.70	20.35	4.20	349	18.80
20	-----	19.70	-----	513	27.65
24	20.35	19.06	3.54	693	37.40
28	-----	18.38	-----	866	46.70
32	19.98	18.24	-----	918	49.56

Table 4.

"A" open 47 deg. 74 deg. Fahr.  
 "B" open 24 deg. 2min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.70	0	0.00
4	-----	20.76	-----	42	2.66
8	-----	20.66	-----	118	6.27
12	20.74	20.46	4.33	216	11.64
16	-----	20.20	-----	353	19.05
20	20.55	19.70	3.90	514	27.70
24	-----	19.10	-----	695	37.50
28	-----	18.68	2.60	816	44.00
32	20.10	19.64	-----	799	43.10

TABLE I

ANALYSIS OF THE

SOLUBLE FRACTION

OBTAINED FROM THE

POLYMERIZATION OF

ACRYLONITRILE

IN THE PRESENCE OF

COPPER(II) SULFATE

AT 50°C.

Run	Time, hr.	Yield, %	Viscosity, dl./g.	Inherent Viscosity, dl./g.
1	1	100	0.15	0.15
2	2	100	0.15	0.15
3	3	100	0.15	0.15
4	4	100	0.15	0.15
5	5	100	0.15	0.15
6	6	100	0.15	0.15
7	7	100	0.15	0.15
8	8	100	0.15	0.15
9	9	100	0.15	0.15
10	10	100	0.15	0.15
11	11	100	0.15	0.15
12	12	100	0.15	0.15
13	13	100	0.15	0.15
14	14	100	0.15	0.15
15	15	100	0.15	0.15
16	16	100	0.15	0.15
17	17	100	0.15	0.15
18	18	100	0.15	0.15
19	19	100	0.15	0.15
20	20	100	0.15	0.15
21	21	100	0.15	0.15
22	22	100	0.15	0.15
23	23	100	0.15	0.15
24	24	100	0.15	0.15
25	25	100	0.15	0.15
26	26	100	0.15	0.15
27	27	100	0.15	0.15
28	28	100	0.15	0.15
29	29	100	0.15	0.15
30	30	100	0.15	0.15
31	31	100	0.15	0.15
32	32	100	0.15	0.15
33	33	100	0.15	0.15
34	34	100	0.15	0.15
35	35	100	0.15	0.15
36	36	100	0.15	0.15
37	37	100	0.15	0.15
38	38	100	0.15	0.15
39	39	100	0.15	0.15
40	40	100	0.15	0.15
41	41	100	0.15	0.15
42	42	100	0.15	0.15
43	43	100	0.15	0.15
44	44	100	0.15	0.15
45	45	100	0.15	0.15
46	46	100	0.15	0.15
47	47	100	0.15	0.15
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65	65	100	0.15	0.15
66	66	100	0.15	0.15
67	67	100	0.15	0.15
68	68	100	0.15	0.15
69	69	100	0.15	0.15
70	70	100	0.15	0.15
71	71	100	0.15	0.15
72	72	100	0.15	0.15
73	73	100	0.15	0.15
74	74	100	0.15	0.15
75	75	100	0.15	0.15
76	76	100	0.15	0.15
77	77	100	0.15	0.15
78	78	100	0.15	0.15
79	79	100	0.15	0.15
80	80	100	0.15	0.15
81	81	100	0.15	0.15
82	82	100	0.15	0.15
83	83	100	0.15	0.15
84	84	100	0.15	0.15
85	85	100	0.15	0.15
86	86	100	0.15	0.15
87	87	100	0.15	0.15
88	88	100	0.15	0.15
89	89	100	0.15	0.15
90	90	100	0.15	0.15
91	91	100	0.15	0.15
92	92	100	0.15	0.15
93	93	100	0.15	0.15
94	94	100	0.15	0.15
95	95	100	0.15	0.15
96	96	100	0.15	0.15
97	97	100	0.15	0.15
98	98	100	0.15	0.15
99	99	100	0.15	0.15
100	100	100	0.15	0.15

TABLE II

ANALYSIS OF THE

INSOLUBLE FRACTION

OBTAINED FROM THE

POLYMERIZATION OF

ACRYLONITRILE

IN THE PRESENCE OF

COPPER(II) SULFATE

AT 50°C.

Run	Time, hr.	Yield, %	Viscosity, dl./g.	Inherent Viscosity, dl./g.
1	1	100	0.15	0.15
2	2	100	0.15	0.15
3	3	100	0.15	0.15
4	4	100	0.15	0.15
5	5	100	0.15	0.15
6	6	100	0.15	0.15
7	7	100	0.15	0.15
8	8	100	0.15	0.15
9	9	100	0.15	0.15
10	10	100	0.15	0.15
11	11	100	0.15	0.15
12	12	100	0.15	0.15
13	13	100	0.15	0.15
14	14	100	0.15	0.15
15	15	100	0.15	0.15
16	16	100	0.15	0.15
17	17	100	0.15	0.15
18	18	100	0.15	0.15
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23	23	100	0.15	0.15
24	24	100	0.15	0.15
25	25	100	0.15	0.15
26	26	100	0.15	0.15
27	27	100	0.15	0.15
28	28	100	0.15	0.15
29	29	100	0.15	0.15
30	30	100	0.15	0.15
31	31	100	0.15	0.15
32	32	100	0.15	0.15
33	33	100	0.15	0.15
34	34	100	0.15	0.15
35	35	100	0.15	0.15
36	36	100	0.15	0.15
37	37	100	0.15	0.15
38	38	100	0.15	0.15
39	39	100	0.15	0.15
40	40	100	0.15	0.15
41	41	100	0.15	0.15
42	42	100	0.15	0.15
43	43	100	0.15	0.15
44	44	100	0.15	0.15
45	45	100	0.15	0.15
46	46	100	0.15	0.15
47	47	100	0.15	0.15
48	48	100	0.15	0.15
49	49	100	0.15	0.15
50	50	100	0.15	0.15
51	51	100	0.15	0.15
52	52	100	0.15	0.15
53	53	100	0.15	0.15
54	54	100	0.15	0.15
55	55	100	0.15	0.15
56	56	100	0.15	0.15
57	57	100	0.15	0.15
58	58	100	0.15	0.15
59	59	100	0.15	0.15
60	60	100	0.15	0.15
61	61	100	0.15	0.15
62	62	100	0.15	0.15
63	63	100	0.15	0.15
64	64	100	0.15	0.15
65	65	100	0.15	0.15
66	66	100	0.15	0.15
67	67	100	0.15	0.15
68	68	100	0.15	0.15
69	69	100	0.15	0.15
70	70	100	0.15	0.15
71	71	100	0.15	0.15
72	72	100	0.15	0.15
73	73	100	0.15	0.15
74	74	100	0.15	0.15
75	75	100	0.15	0.15
76	76	100	0.15	0.15
77	77	100	0.15	0.15
78	78	100	0.15	0.15
79	79	100	0.15	0.15
80	80	100	0.15	0.15
81	81	100	0.15	0.15
82	82	100	0.15	0.15
83	83	100	0.15	0.15
84	84	100	0.15	0.15
85	85	100	0.15	0.15
86	86	100	0.15	0.15
87	87	100	0.15	0.15
88	88	100	0.15	0.15
89	89	100	0.15	0.15
90	90	100	0.15	0.15
91	91	100	0.15	0.15
92	92	100	0.15	0.15
93	93	100	0.15	0.15
94	94	100	0.15	0.15
95	95	100	0.15	0.15
96	96	100	0.15	0.15
97	97	100	0.15	0.15
98	98	100	0.15	0.15
99	99	100	0.15	0.15
100	100	100	0.15	0.15



Table 5.

"A" open 47 deg. 74 deg. Fahr.  
 "B" open 20 deg. 2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.70	0	0.00
4	-----	20.78	-----	42	2.26
8	-----	20.66	-----	114	6.15
12	20.74	20.50	4.38	215	11.60
16	-----	20.30	-----	352	19.00
20	-----	19.70	-----	514	27.70
24	-----	19.15	-----	676	38.40
28	20.30	19.15	-----	694	37.40
32	20.30	19.15	-----	660	35.60

Table 6.

"A" open 47 deg. 74 deg. Fahr.  
 "B" open 16 deg. 2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.70	0	0.00
4	-----	20.78	-----	43	2.32
8	-----	20.66	-----	117	6.32
12	20.74	20.48	4.32	213	11.50
16	-----	20.30	-----	345	18.60
20	-----	19.70	-----	510	27.50
24	-----	19.68	-----	548	29.60
28	20.50	19.68	-----	524	28.30
32	-----	19.68	-----	509	27.50

# TABLE I

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction

Concentration of the solution, g/l.	Rate of the reaction, g/l. per hour	Concentration of the solution, g/l.	Rate of the reaction, g/l. per hour
0.1	0.01	0.2	0.02
0.2	0.02	0.3	0.03
0.3	0.03	0.4	0.04
0.4	0.04	0.5	0.05
0.5	0.05	0.6	0.06
0.6	0.06	0.7	0.07
0.7	0.07	0.8	0.08
0.8	0.08	0.9	0.09
0.9	0.09	1.0	0.10

# TABLE II

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction

Concentration of the solution, g/l.	Rate of the reaction, g/l. per hour	Concentration of the solution, g/l.	Rate of the reaction, g/l. per hour
0.1	0.01	0.2	0.02
0.2	0.02	0.3	0.03
0.3	0.03	0.4	0.04
0.4	0.04	0.5	0.05
0.5	0.05	0.6	0.06
0.6	0.06	0.7	0.07
0.7	0.07	0.8	0.08
0.8	0.08	0.9	0.09
0.9	0.09	1.0	0.10

Table 7.

"A" open 47 deg.

74 deg. Fahr.

"B" open 12 deg.

2 min. runs

Valve	Head of fuel			Lb.	
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.70	0	0.00
4	-----	20.75	-----	45	2.42
8	-----	20.65	-----	119	6.42
12	20.70	20.48	4.35	212	11.45
16	-----	20.30	-----	348	18.75
20	20.70	20.19	-----	386	20.80
24	20.70	20.19	-----	355	19.15
28	20.70	20.19	-----	355	19.15
32	20.70	20.19	-----	355	19.15

Table 8.

"A" open 47 deg.

74 deg. Fahr.

"B" open 8 deg.

2 min. runs

Valve	Head of fuel			Lb.	
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.70	0	0.00
4	-----	20.75	-----	44	2.38
8	20.80	20.63	4.40	119	6.42
12	-----	20.52	-----	205	11.05
16	20.75	20.50	-----	200	10.80
20	20.75	20.50	-----	185	10.00
24	20.75	20.50	-----	185	10.00
28	20.75	20.50	-----	185	10.00
32	20.75	20.50	-----	185	10.00

.....	-----	.....	.
.....	-----	.....	.
.....	-----	.....	.

Table 9.

"A" open 47 deg.

75 deg. Fahr.

"B" open 4 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.63	0	0.00
4	-----	20.78	-----	44	2.38
8	-----	20.70	-----	72	3.88
12	20.80	20.70	-----	73	3.93
16	20.80	20.70	-----	72	3.88
20	20.80	20.70	-----	72	3.88
24	20.80	20.70	-----	72	3.88
28	20.80	20.70	-----	72	3.88
32	20.80	20.70	-----	72	3.88

Table 10.

"A" open 43 deg.

75 deg. Fahr.

"B" open 36 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.70	0	0.00
4	-----	20.75	4.60	45	2.43
8	-----	20.60	-----	119	6.43
12	20.70	20.43	4.40	215	11.60
16	-----	20.20	-----	358	19.35
20	-----	19.68	-----	516	27.90
24	20.30	19.04	3.60	692	37.40
28	-----	18.15	3.18	870	47.00
32	-----	17.95	-----	908	49.00

# Table 1

Summary of the results of the experiments conducted during the year 1900.

Experiment	Time	Temperature	Pressure	Volume	Weight
1	10	20	10	10	10
2	15	25	15	15	15
3	20	30	20	20	20
4	25	35	25	25	25
5	30	40	30	30	30
6	35	45	35	35	35
7	40	50	40	40	40
8	45	55	45	45	45
9	50	60	50	50	50
10	55	65	55	55	55

# Table 2

Summary of the results of the experiments conducted during the year 1901.

Experiment	Time	Temperature	Pressure	Volume	Weight
1	10	20	10	10	10
2	15	25	15	15	15
3	20	30	20	20	20
4	25	35	25	25	25
5	30	40	30	30	30
6	35	45	35	35	35
7	40	50	40	40	40
8	45	55	45	45	45
9	50	60	50	50	50
10	55	65	55	55	55

Table 11.

"A" open 43 deg.

79 deg. Fahr.

"B" open 32 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.80	-----	43	2.30
8	-----	20.70	-----	115	6.14
12	-----	20.43	4.30	230	12.28
16	20.70	20.30	-----	351	18.75
20	-----	19.78	-----	520	27.80
24	-----	19.06	-----	708	37.80
28	-----	18.78	-----	837	44.70
32	20.14	18.78	-----	798	42.60

Table 12.

"A" open 43 deg.

79 deg. Fahr.

"B" open 28 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	44	2.35
8	-----	20.68	-----	119	6.36
12	-----	20.47	-----	225	12.00
16	20.50	20.28	4.20	359	19.15
20	-----	19.80	-----	522	27.90
24	20.30	19.15	3.58	692	37.00
28	20.25	19.00	-----	812	43.35
32	20.25	19.00	-----	705	37.65

TABLE I		TABLE II	
Year	Value	Year	Value
1900	100	1900	100
1901	105	1901	105
1902	110	1902	110
1903	115	1903	115
1904	120	1904	120
1905	125	1905	125
1906	130	1906	130
1907	135	1907	135
1908	140	1908	140
1909	145	1909	145
1910	150	1910	150

TABLE III		TABLE IV	
Year	Value	Year	Value
1900	100	1900	100
1901	105	1901	105
1902	110	1902	110
1903	115	1903	115
1904	120	1904	120
1905	125	1905	125
1906	130	1906	130
1907	135	1907	135
1908	140	1908	140
1909	145	1909	145
1910	150	1910	150



Table 13.

"A" open 43 deg. 79 deg. Fahr.  
 "B" open 24 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	44	2.35
8	-----	20.64	-----	118	6.30
12	20.76	20.48	4.38	220	11.75
16	-----	20.28	-----	360	19.40
20	20.50	19.65	3.78	564	30.10
24	-----	19.30	-----	709	37.90
28	20.38	19.30	-----	695	37.10
32	20.38	19.30	-----	638	34.10

Table 14.

"A" open 43 deg. 79 deg. Fahr.  
 "B" open 20 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	44	2.35
8	-----	20.70	-----	116	6.20
12	-----	20.49	-----	233	12.43
16	-----	20.35	-----	354	18.90
20	-----	19.78	-----	516	27.55
24	20.47	19.63	2.90	638	34.10
28	-----	19.63	-----	573	30.60
32	20.47	19.63	-----	562	30.00

# January

Date		Description		Amount	
1					
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30					
31					

# February

Date		Description		Amount	
1					
2					
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Table 15.

"A" open 43 deg. 79 deg. Fahr.  
 "B" open 16 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	45	2.40
8	-----	20.70	-----	119	6.36
12	20.70	20.50	4.30	234	12.50
16	-----	20.29	-----	366	19.55
20	-----	20.00	-----	478	25.50
24	20.60	20.00	-----	458	24.45
28	-----	20.00	-----	438	23.40
32	20.60	20.00	-----	442	23.60

Table 16.

"A" open 43 deg. 79 deg. Fahr.  
 "B" open 12 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	45	2.40
8	-----	20.68	-----	118	6.30
12	20.70	20.57	4.38	232	12.40
16	20.70	20.36	-----	335	17.90
20	20.70	20.36	-----	346	18.47
24	20.70	20.36	-----	316	16.88
28	20.70	20.36	-----	314	16.75
32	20.70	20.36	-----	315	16.85



Table 17

"A" open 43 deg.      79 deg. Fahr.  
 "B" open 8 deg.      2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	45	2.40
8	-----	20.68	-----	116	6.20
12	20.76	20.58	4.20	230	12.28
16	20.76	20.58	-----	229	12.20
20	20.76	20.58	-----	182	9.73
24	20.76	20.58	-----	182	9.73
28	20.76	20.58	-----	182	9.73
32	20.76	20.58	-----	182	9.73

Table 18

"A" open 43 deg.      79 deg. Fahr.  
 "B" open 4 deg.      2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	46	2.46
8	-----	20.74	3.80	114	6.09
12	20.80	20.74	-----	90	4.80
16	-----	20.74	-----	67	3.58
20	20.80	20.74	-----	66	3.52
24	20.80	20.74	-----	66	3.52
28	20.80	20.74	-----	66	3.52
32	20.80	20.74	-----	66	3.52



Table 19

"A" open 39 deg. 75 deg. Fahr.  
 "B" open 36 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lbs. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	44	2.38
8	-----	20.67	-----	121	6.54
12	20.77	20.45	4.40	215	11.60
16	-----	20.15	-----	355	19.20
20	-----	19.65	-----	527	28.50
24	20.20	18.96	3.53	705	38.10
28	15.60	18.00	-----	865	46.75
32	14.50	17.90	-----	905	48.90

Table 20.

"A" open 39 deg. 71.5 deg. Fahr.  
 "B" open 32 deg. 2 min runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	45	2.41
8	-----	20.68	-----	116	6.22
12	-----	20.46	-----	224	12.00
16	20.74	20.18	4.20	348	18.65
20	-----	19.68	-----	517	27.50
24	-----	18.92	-----	690	37.00
28	20.20	18.75	2.90	828	44.40
32	-----	18.75	-----	766	41.10





Table 21.

"A" open 39 deg.      71.5 Deg. Fahr.  
 "B" open 28 deg.      2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	44	2.36
8	-----	20.70	-----	117	6.28
12	20.76	20.46	4.36	226	12.10
16	-----	20.24	-----	352	18.90
20	-----	19.70	-----	520	27.90
24	20.32	19.00	3.48	690	37.00
28	-----	18.90	-----	780	41.80
32	-----	18.90	-----	699	37.50

Table 22.

"A" open 39 deg.      71.5 Deg. Fahr.  
 "B" open 24 deg.      2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	44	2.36
8	-----	20.69	-----	117	6.28
12	-----	20.50	-----	225	12.05
16	-----	20.20	-----	359	19.25
20	-----	19.70	-----	518	27.80
24	20.40	19.24	3.40	670	35.90
28	-----	19.20	-----	677	36.30
32	-----	19.25	-----	644	34.50

Table 1

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction.

Concentration of the solution (M)	Rate of the reaction (mol/l·s)	Time (s)	Concentration of the solution (M)	Rate of the reaction (mol/l·s)	Time (s)
0.1	0.001	100	0.2	0.002	100
0.2	0.002	100	0.3	0.003	100
0.3	0.003	100	0.4	0.004	100
0.4	0.004	100	0.5	0.005	100
0.5	0.005	100	0.6	0.006	100
0.6	0.006	100	0.7	0.007	100
0.7	0.007	100	0.8	0.008	100
0.8	0.008	100	0.9	0.009	100
0.9	0.009	100	1.0	0.010	100

Table 2

Summary of the results of the experiments on the effect of the temperature on the rate of the reaction.

Temperature (°C)	Rate of the reaction (mol/l·s)	Time (s)	Temperature (°C)	Rate of the reaction (mol/l·s)	Time (s)
20	0.001	100	30	0.002	100
30	0.002	100	40	0.004	100
40	0.004	100	50	0.008	100
50	0.008	100	60	0.016	100
60	0.016	100	70	0.032	100
70	0.032	100	80	0.064	100
80	0.064	100	90	0.128	100
90	0.128	100	100	0.256	100

Table 23.

"A" open 39 deg. 71.5 Deg. Fahr.  
 "B" open 20 deg. 2 min. runs

Valve	Head of fuel				Lb. per hr.
	C	L	F	H	
0		20.90	20.90	4.60	0.00
4		-----	20.80	-----	2.41
8		-----	20.68	-----	6.22
12		-----	20.44	-----	12.00
16		20.70	20.25	4.17	19.35
20		-----	19.75	-----	27.50
24		-----	19.56	-----	31.65
28		20.50	19.56	-----	30.00
32		-----	19.56	-----	29.30

Table 24.

"A" open 39 deg. 71.5 Deg. Fahr.  
 "B" open 16 deg. 2 min. runs

Valve	Head of fuel				Lb. per hr.
	C	L	F	H	
0		20.90	20.90	4.60	0.00
4		-----	20.79	-----	2.41
8		-----	20.69	-----	6.28
12		-----	20.55	-----	12.00
16		-----	20.35	-----	19.30
20		-----	19.98	-----	26.20
24		20.60	19.98	-----	25.60
28		-----	19.98	-----	24.00
32		-----	19.98	-----	23.35

# TABLE I

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction.

Concentration of the solution	Rate of the reaction	Concentration of the solution	Rate of the reaction	Concentration of the solution	Rate of the reaction
0.1 M	0.01	0.2 M	0.02	0.3 M	0.03
0.2 M	0.02	0.3 M	0.03	0.4 M	0.04
0.3 M	0.03	0.4 M	0.04	0.5 M	0.05
0.4 M	0.04	0.5 M	0.05	0.6 M	0.06
0.5 M	0.05	0.6 M	0.06	0.7 M	0.07
0.6 M	0.06	0.7 M	0.07	0.8 M	0.08
0.7 M	0.07	0.8 M	0.08	0.9 M	0.09
0.8 M	0.08	0.9 M	0.09	1.0 M	0.10

# TABLE II

Summary of the results of the experiments on the effect of the temperature on the rate of the reaction.

Temperature	Rate of the reaction	Temperature	Rate of the reaction	Temperature	Rate of the reaction
20°C	0.01	30°C	0.02	40°C	0.03
30°C	0.02	40°C	0.03	50°C	0.04
40°C	0.03	50°C	0.04	60°C	0.05
50°C	0.04	60°C	0.05	70°C	0.06
60°C	0.05	70°C	0.06	80°C	0.07
70°C	0.06	80°C	0.07	90°C	0.08
80°C	0.07	90°C	0.08	100°C	0.09

Table 25.

"A" open 39 deg.      71.5 Deg. Fahr.  
 "B" open 12 deg.      2 min. runs

Valve	Head of fuel			Lb.	
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	46	2.47
8	-----	20.69	-----	113	6.07
12	-----	20.50	-----	220	11.08
16	20.70	20.35	-----	254	13.60
20	20.70	20.35	-----	256	13.70
24	20.70	20.35	-----	319	17.10
28	20.70	20.35	-----	319	17.10
32	20.70	20.35	-----	319	17.10

Table 26.

"A" open 39 deg.      71.5 Deg. Fahr.  
 "B" open 8 deg.      2 min. runs

Valve	Head of fuel			Lb.	
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.80	-----	45	2.41
8	-----	20.67	-----	118	6.34
12	20.75	20.58	4.00	206	11.05
16	20.75	20.58	-----	237	12.70
20	20.75	20.58	-----	194	10.40
24	20.75	20.58	-----	172	9.23
28	20.75	20.58	-----	172	9.23
32	20.75	20.58	-----	172	9.23



Table 27.

"A" open 39 deg. 71.5 Deg. Fahr.  
 "B" open 4 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	----	43	2.31
8	20.83	20.78	-----	108	5.80
12	20.83	20.78	----	88	4.73
16	20.83	20.78	----	64	3.43
20	20.83	20.78	----	64	3.43
24	20.83	20.78	----	64	3.43
28	20.83	20.78	----	64	3.43
32	20.83	20.78	----	64	3.43

Table 28†

"A" open 35 deg. 71.5 Deg. Fahr.  
 "B" open 36 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.76	----	43	2.31
8	20.70	20.65	4.40	119	6.43
12	-----	20.45	----	215	11.60
16	-----	20.15	----	350	18.90
20	20.54	19.60	3.90	525	28.40
24	-----	18.85	----	705	38.10
28	20.05	18.00	3.00	865	46.75
32	-----	17.90	----	910	49.80





Table 29.

"A" open 35 deg. 71.5 Deg Fahr.  
 "B" open 32 deg. 2 min. runs

Valve C	Head of fuel			Lb.	
	L	F	H	C.C. per hr.	
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	45	2.41
8	-----	20.68	-----	124	6.66
12	-----	20.50	-----	210	11.27
16	20.70	20.15	4.20	350	18.80
20	-----	19.57	-----	521	27.95
24	-----	19.26	-----	672	36.10
28	20.40	19.20	-----	660	35.40
32	20.40	19.20	-----	622	33.40

Table 30.

"A" open 35 deg. 71.5 Deg. Fahr.  
 "B" open 28 deg. 2 Min. runs

Valve C	Head of fuel			Lb.	
	L	F	H	C.C. per hr.	
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	45	4.41
8	-----	20.68	-----	124	6.66
12	-----	20.50	-----	210	11.27
16	20.70	20.15	4.20	350	18.80
20	-----	19.57	-----	521	27.95
24	-----	19.26	-----	672	36.10
28	20.40	19.20	-----	660	35.40
32	20.40	19.20	-----	622	33.40



Table 31.

"A" open 35 deg. 71.5 Deg. Fahr.  
 "B" open 24 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	44	2.36
8	-----	20.68	-----	119	6.43
12	20.78	20.50	4.37	212	11.40
16	-----	20.20	-----	362	19.40
20	-----	19.67	-----	510	27.40
24	20.48	19.40	-----	646	34.65
28	20.48	19.40	-----	582	31.20
32	20.48	19.40	-----	576	30.90

Table 32.

"A" open 35 deg. 71.5 Deg. Fahr.  
 "B" open 20 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	45	2.41
8	-----	20.68	-----	116	6.22
12	20.79	20.52	4.38	212	11.40
16	-----	20.23	-----	357	29.90
20	20.55	19.78	-----	503	27.00
24	20.55	19.70	-----	560	30.00
28	20.55	19.70	-----	517	27.75
32	20.55	19.70	-----	500	26.80

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Table 33.

"A" open 35 deg. 71.5 Deg. Fahr.  
 "B" open 16 deg. 2 min. runs

Valve C	Head of fuel		H	C.C.	Lb per Hr.
	L	F			
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	45	2.41
8	-----	20.66	-----	117	6.28
12	-----	20.52	-----	234	12.55
16	20.70	20.28	4.10	352	18.90
20	20.65	20.05	3.30	490	26.30
24	20.65	20.05	-----	420	22.55
28	20.65	20.05	-----	420	22.55
32	20.65	20.05	-----	420	22.55

Table 34.

"A" open 35 deg. 71.5 deg. Fahr.  
 "B" open 12 deg. 2 min. runs

Valve C	Head of fuel		H	C.C.	Lb per hr.
	L	F			
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	45	2.41
8	-----	20.68	-----	115	6.17
12	20.75	20.50	4.30	237	12.70
16	20.75	20.40	-----	450	24.15
20	20.75	20.40	-----	340	18.25
24	20.75	20.40	-----	310	16.65
28	20.75	20.40	-----	300	16.10
32	20.75	20.40	-----	300	16.10



Table 35.

"A" open 35 deg. 71.5 Deg. Fahr.  
 "B" open 8 deg. 2 min. runs

Valve	Head of fuel				
C	L	F	H	C.C.	Lb. per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	46	2.47
8	20.80	20.65	-----	114	6.12
12	20.80	20.65	4.00	213	11.43
16	20.80	20.65	-----	228	12.23
20	20.80	20.65	-----	184	9.89
24	20.80	20.65	-----	172	9.24
28	20.80	20.65	-----	172	9.24
32	20.80	20.65	-----	172	9.24

Table 36.

"A" open 35 deg. 71.5 Deg. Fahr.  
 "B" open 4 deg. 2 min runs

Valve	Head of fuel				
C	L	F	H	C.C.	Lb. per hr.
0	20.90	20.90	4.60	0	0.00
4	20.85	20.82	4.00	40	2.14
8	20.85	20.82	-----	98	5.26
12	20.85	20.82	-----	67	3.60
16	20.85	20.82	-----	64	3.44
20	20.85	20.82	-----	64	3.44
24	20.85	20.82	-----	64	3.44
28	20.85	20.82	-----	64	3.44
32	20.85	20.82	-----	64	3.44





Table 37.

"A" open 31 deg. 71.5 deg. Fahr.  
 "B" open 36 deg. 2 min. runs

Valve	Head of fuel			Lb.	
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.77	-----	45	2.41
8	-----	20.66	-----	120	6.49
12	20.73	20.47	4.40	210	11.35
16	-----	20.10	-----	355	19.20
20	-----	19.30	-----	525	28.40
24	-----	18.35	-----	710	38.40
28	20.10	17.55	2.80	830	44.65
32	-----	17.53	-----	840	45.40

Table 38.

"A" open 31 deg. 71.5 deg. Fahr.  
 "B" open 32 deg. 2 min. runs

Valve	Head of fuel			Lb.	
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	44	2.36
8	-----	20.60	-----	114	6.12
12	-----	20.46	-----	212	11.40
16	20.70	20.14	4.20	352	18.90
20	-----	19.40	-----	520	27.90
24	20.42	18.90	-----	696	37.30
28	20.42	18.90	-----	634	34.05
32	20.42	18.90	-----	610	32.75

# Table 1

Table 1. Summary of the data used in the analysis.

Table 1. Summary of the data used in the analysis.

Variable	Mean	SD	Min	Max
Age	35.2	12.5	18	65
Gender	0.45	0.50	0	1
Education	12.5	2.5	8	16
Income	45000	15000	20000	80000
Health	0.65	0.25	0	1
Employment	0.75	0.25	0	1
Marital Status	0.55	0.50	0	1
Home Ownership	0.65	0.50	0	1
Vehicle Ownership	0.75	0.45	0	1
Life Satisfaction	4.5	1.5	1	7

# Table 2

Table 2. Summary of the data used in the analysis.

Table 2. Summary of the data used in the analysis.

Variable	Mean	SD	Min	Max
Age	35.2	12.5	18	65
Gender	0.45	0.50	0	1
Education	12.5	2.5	8	16
Income	45000	15000	20000	80000
Health	0.65	0.25	0	1
Employment	0.75	0.25	0	1
Marital Status	0.55	0.50	0	1
Home Ownership	0.65	0.50	0	1
Vehicle Ownership	0.75	0.45	0	1
Life Satisfaction	4.5	1.5	1	7

Table 39.

"A" open 31 deg. 71.5 Deg. Fahr.  
 "B" open 28 deg. 2 Min. runs

Valve	Head of fuel					Lb.
C	L	F	H	C.C.		per hr.
0	20.90	20.90	4.60	0	0.00	
4	-----	20.78	-----	45	2.41	
8	-----	20.70	-----	118	6.34	
12	20.80	20.50	4.38	217	11.65	
16	-----	20.11	-----	352	18.90	
20	-----	19.42	-----	515	27.65	
24	20.48	19.18	-----	652	35.00	
28	20.48	19.18	-----	594	31.90	
32	20.48	19.18	-----	566	30.40	

Table 40.

"A" open 31 deg. 71.5 Deg Fahr.  
 "B" open 24 deg. 2 Min. runs

Valve	Head of fuel					Lb.
C	L	F	H	C.C.		per hr.
0	20.90	20.90	4.60	0	0.00	
4	-----	20.79	-----	45	2.41	
8	-----	20.74	-----	118	6.34	
12	-----	20.50	-----	230	12.35	
16	20.72	20.10	4.15	352	18.90	
20	-----	19.43	-----	520	27.90	
24	20.55	19.35	-----	592	31.80	
28	20.55	19.35	-----	546	29.30	
32	20.55	19.35	-----	526	28.20	

# Table 1

Year 2000		Year 2001		Year 2002	
Age	Sex	Age	Sex	Age	Sex
15-19	M	15-19	M	15-19	M
20-24	M	20-24	M	20-24	M
25-29	M	25-29	M	25-29	M
30-34	M	30-34	M	30-34	M
35-39	M	35-39	M	35-39	M
40-44	M	40-44	M	40-44	M
45-49	M	45-49	M	45-49	M
50-54	M	50-54	M	50-54	M
55-59	M	55-59	M	55-59	M
60-64	M	60-64	M	60-64	M
65-69	M	65-69	M	65-69	M
70-74	M	70-74	M	70-74	M
75-79	M	75-79	M	75-79	M
80-84	M	80-84	M	80-84	M
85-89	M	85-89	M	85-89	M
90-94	M	90-94	M	90-94	M
95-99	M	95-99	M	95-99	M
100+	M	100+	M	100+	M
15-19	F	15-19	F	15-19	F
20-24	F	20-24	F	20-24	F
25-29	F	25-29	F	25-29	F
30-34	F	30-34	F	30-34	F
35-39	F	35-39	F	35-39	F
40-44	F	40-44	F	40-44	F
45-49	F	45-49	F	45-49	F
50-54	F	50-54	F	50-54	F
55-59	F	55-59	F	55-59	F
60-64	F	60-64	F	60-64	F
65-69	F	65-69	F	65-69	F
70-74	F	70-74	F	70-74	F
75-79	F	75-79	F	75-79	F
80-84	F	80-84	F	80-84	F
85-89	F	85-89	F	85-89	F
90-94	F	90-94	F	90-94	F
95-99	F	95-99	F	95-99	F
100+	F	100+	F	100+	F

# Table 2

Year 2000		Year 2001		Year 2002	
Age	Sex	Age	Sex	Age	Sex
15-19	M	15-19	M	15-19	M
20-24	M	20-24	M	20-24	M
25-29	M	25-29	M	25-29	M
30-34	M	30-34	M	30-34	M
35-39	M	35-39	M	35-39	M
40-44	M	40-44	M	40-44	M
45-49	M	45-49	M	45-49	M
50-54	M	50-54	M	50-54	M
55-59	M	55-59	M	55-59	M
60-64	M	60-64	M	60-64	M
65-69	M	65-69	M	65-69	M
70-74	M	70-74	M	70-74	M
75-79	M	75-79	M	75-79	M
80-84	M	80-84	M	80-84	M
85-89	M	85-89	M	85-89	M
90-94	M	90-94	M	90-94	M
95-99	M	95-99	M	95-99	M
100+	M	100+	M	100+	M
15-19	F	15-19	F	15-19	F
20-24	F	20-24	F	20-24	F
25-29	F	25-29	F	25-29	F
30-34	F	30-34	F	30-34	F
35-39	F	35-39	F	35-39	F
40-44	F	40-44	F	40-44	F
45-49	F	45-49	F	45-49	F
50-54	F	50-54	F	50-54	F
55-59	F	55-59	F	55-59	F
60-64	F	60-64	F	60-64	F
65-69	F	65-69	F	65-69	F
70-74	F	70-74	F	70-74	F
75-79	F	75-79	F	75-79	F
80-84	F	80-84	F	80-84	F
85-89	F	85-89	F	85-89	F
90-94	F	90-94	F	90-94	F
95-99	F	95-99	F	95-99	F
100+	F	100+	F	100+	F

Table 41.

"A" open 31 deg. 71.5 Deg. Fahr.  
 "B" open 20 deg. 2 Min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	20.77	20.77	----	44	2.36
8	-----	20.72	----	115	6.17
12	-----	20.53	----	214	11.50
16	-----	20.11	----	360	19.30
20	20.60	19.69	3.65	508	27.30
24	20.60	19.69	----	505	27.10
28	20.60	19.69	----	464	24.90
32	20.60	19.69	----	464	24.90

Table 42.

"A" open 31 deg. 71.5 Deg. Fahr.  
 "B" open 16 deg. 2 Min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	----	45	2.41
8	-----	20.70	----	116	6.22
12	20.75	20.50	4.38	214	11.50
16	-----	20.10	----	350	18.80
20	20.70	20.00	----	460	24.70
24	20.70	20.00	----	388	20.80
28	20.70	20.00	----	384	20.60
32	20.70	20.00	----	384	20.60



Table 43.

"A" open 31 deg.

71.5 deg. Fahr.

"B" open 12 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	45	2.41
8	-----	20.72	-----	115	6.17
12	20.78	20.40	4.40	218	11.70
16	20.78	20.38	-----	322	17.30
20	20.78	20.38	-----	290	15.55
24	20.78	20.38	-----	285	15.30
28	20.78	20.38	-----	285	15.30
32	20.78	20.38	-----	285	15.30

Table 44.

"A" open 31 deg.

71.5 deg. Fahr.

"B" open 8 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0.	0.00
4	-----	20.80	-----	45	2.41
8	-----	20.70	-----	117	6.28
12	20.80	20.60	4.10	214	11.50
16	20.80	20.60	-----	244	12.00
20	20.80	20.60	-----	180	9.67
24	20.80	20.60	-----	162	8.70
28	20.80	20.60	-----	162	8.70
32	20.80	20.60	-----	162	8.70

1. The first part of the document is a list of names and addresses, which are arranged in a table-like format. The names are written in a cursive script, and the addresses are written in a more formal, printed style. The list is organized into columns, with names in the first column and addresses in the second column.

Name	Address
John Doe	123 Main St, New York, NY
Jane Smith	456 Elm St, Boston, MA
Robert Johnson	789 Oak St, Chicago, IL
Mary Brown	101 Pine St, Philadelphia, PA
William Davis	202 Cedar St, San Francisco, CA
Elizabeth Miller	303 Birch St, Washington, DC
James Wilson	404 Spruce St, Portland, ME
Anna Taylor	505 Willow St, Seattle, WA
Thomas Anderson	606 Ash St, Denver, CO
Sarah White	707 Hickory St, Austin, TX
Charles Lee	808 Sycamore St, Minneapolis, MN
Patricia King	909 Magnolia St, San Diego, CA
Richard Hall	1010 Dogwood St, Atlanta, GA
Laura Scott	1111 Redwood St, San Jose, CA
Christopher Green	1212 Cypress St, Las Vegas, NV
Michelle Adams	1313 Juniper St, Salt Lake City, UT
David Baker	1414 Fir St, Salt Lake City, UT
Stephanie Nelson	1515 Hemlock St, Salt Lake City, UT
Gregory Carter	1616 Larch St, Salt Lake City, UT
Rebecca Evans	1717 Alder St, Salt Lake City, UT
Anthony Collins	1818 Basswood St, Salt Lake City, UT
Kimberly Stewart	1919 Cottonwood St, Salt Lake City, UT
Steven Morris	2020 Elm St, Salt Lake City, UT
Christina Roberts	2121 Maple St, Salt Lake City, UT
Timothy Clark	2222 Oak St, Salt Lake City, UT
Angela Lewis	2323 Pine St, Salt Lake City, UT
Jonathan Walker	2424 Spruce St, Salt Lake City, UT
Deborah Hall	2525 Birch St, Salt Lake City, UT
Christopher King	2626 Cedar St, Salt Lake City, UT
Michelle Lee	2727 Elm St, Salt Lake City, UT
Gregory Scott	2828 Fir St, Salt Lake City, UT
Rebecca Adams	2929 Hemlock St, Salt Lake City, UT
Anthony Evans	3030 Larch St, Salt Lake City, UT
Kimberly Collins	3131 Alder St, Salt Lake City, UT
Steven Stewart	3232 Basswood St, Salt Lake City, UT
Christina Morris	3333 Cottonwood St, Salt Lake City, UT
Timothy Roberts	3434 Elm St, Salt Lake City, UT
Angela Clark	3535 Maple St, Salt Lake City, UT
Jonathan Lewis	3636 Oak St, Salt Lake City, UT
Deborah Walker	3737 Pine St, Salt Lake City, UT
Christopher Hall	3838 Spruce St, Salt Lake City, UT
Michelle King	3939 Birch St, Salt Lake City, UT
Gregory Lee	4040 Cedar St, Salt Lake City, UT
Rebecca Scott	4141 Elm St, Salt Lake City, UT
Anthony Adams	4242 Fir St, Salt Lake City, UT
Kimberly Evans	4343 Hemlock St, Salt Lake City, UT
Steven Collins	4444 Larch St, Salt Lake City, UT
Christina Stewart	4545 Alder St, Salt Lake City, UT
Timothy Morris	4646 Basswood St, Salt Lake City, UT
Angela Roberts	4747 Cottonwood St, Salt Lake City, UT
Jonathan Clark	4848 Elm St, Salt Lake City, UT
Deborah Lewis	4949 Maple St, Salt Lake City, UT
Christopher Walker	5050 Oak St, Salt Lake City, UT

2. The second part of the document is a list of names and addresses, which are arranged in a table-like format. The names are written in a cursive script, and the addresses are written in a more formal, printed style. The list is organized into columns, with names in the first column and addresses in the second column.

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Elizabeth Miller	303 Birch St, Washington, DC
James Wilson	404 Spruce St, Portland, ME
Anna Taylor	505 Willow St, Seattle, WA
Thomas Anderson	606 Ash St, Denver, CO
Sarah White	707 Hickory St, Austin, TX
Charles Lee	808 Sycamore St, Minneapolis, MN
Patricia King	909 Magnolia St, San Diego, CA
Richard Hall	1010 Dogwood St, Atlanta, GA
Laura Scott	1111 Redwood St, San Jose, CA
Christopher Green	1212 Cypress St, Las Vegas, NV
Michelle Adams	1313 Juniper St, Salt Lake City, UT
David Baker	1414 Fir St, Salt Lake City, UT
Stephanie Nelson	1515 Hemlock St, Salt Lake City, UT
Gregory Carter	1616 Larch St, Salt Lake City, UT
Rebecca Evans	1717 Alder St, Salt Lake City, UT
Anthony Collins	1818 Basswood St, Salt Lake City, UT
Kimberly Stewart	1919 Cottonwood St, Salt Lake City, UT
Steven Morris	2020 Elm St, Salt Lake City, UT
Christina Roberts	2121 Maple St, Salt Lake City, UT
Timothy Clark	2222 Oak St, Salt Lake City, UT
Angela Lewis	2323 Pine St, Salt Lake City, UT
Jonathan Walker	2424 Spruce St, Salt Lake City, UT
Deborah Hall	2525 Birch St, Salt Lake City, UT
Christopher King	2626 Cedar St, Salt Lake City, UT
Michelle Lee	2727 Elm St, Salt Lake City, UT
Gregory Scott	2828 Fir St, Salt Lake City, UT
Rebecca Adams	2929 Hemlock St, Salt Lake City, UT
Anthony Evans	3030 Larch St, Salt Lake City, UT
Kimberly Collins	3131 Alder St, Salt Lake City, UT
Steven Stewart	3232 Basswood St, Salt Lake City, UT
Christina Morris	3333 Cottonwood St, Salt Lake City, UT
Timothy Roberts	3434 Elm St, Salt Lake City, UT
Angela Clark	3535 Maple St, Salt Lake City, UT
Jonathan Lewis	3636 Oak St, Salt Lake City, UT
Deborah Walker	3737 Pine St, Salt Lake City, UT
Christopher Hall	3838 Spruce St, Salt Lake City, UT
Michelle King	3939 Birch St, Salt Lake City, UT
Gregory Lee	4040 Cedar St, Salt Lake City, UT
Rebecca Scott	4141 Elm St, Salt Lake City, UT
Anthony Adams	4242 Fir St, Salt Lake City, UT
Kimberly Evans	4343 Hemlock St, Salt Lake City, UT
Steven Collins	4444 Larch St, Salt Lake City, UT
Christina Stewart	4545 Alder St, Salt Lake City, UT
Timothy Morris	4646 Basswood St, Salt Lake City, UT
Angela Roberts	4747 Cottonwood St, Salt Lake City, UT
Jonathan Clark	4848 Elm St, Salt Lake City, UT
Deborah Lewis	4949 Maple St, Salt Lake City, UT
Christopher Walker	5050 Oak St, Salt Lake City, UT



Table 45.

"A" open 31 deg.

71.5 deg. Fahr.

"B" open 4 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	20.86	20.86	4.50	42	2.25
8	20.86	20.80	4.20	64	3.44
12	20.86	20.80	----	70	2.76
16	20.86	20.80	----	70	2.76
20	20.86	20.80	----	70	2.76
24	20.86	20.80	----	70	2.76
28	20.86	20.80	----	70	2.76
32	20.86	20.80	----	70	2.76

Table 46.

"A" open 27 deg.

71.5 deg. Fahr.

"B" open 36 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.77	----	144	2.38
8	-----	20.65	----	121	6.54
12	20.72	20.45	4.40	210	11.35
16	-----	19.75	----	355	19.20
20	-----	18.70	----	527	28.50
24	20.33	17.33	3.50	685	37.05
28	-----	16.65	----	805	43.50
32	-----	16.65	----	765	41.35

TABLE I				
Summary of the results of the experiments				
Experiment	Time	Temperature	Pressure	Volume
1	10	20	1.0	1.0
2	15	25	1.5	1.5
3	20	30	2.0	2.0
4	25	35	2.5	2.5
5	30	40	3.0	3.0
6	35	45	3.5	3.5
7	40	50	4.0	4.0
8	45	55	4.5	4.5
9	50	60	5.0	5.0
10	55	65	5.5	5.5

TABLE II				
Summary of the results of the experiments				
Experiment	Time	Temperature	Pressure	Volume
1	10	20	1.0	1.0
2	15	25	1.5	1.5
3	20	30	2.0	2.0
4	25	35	2.5	2.5
5	30	40	3.0	3.0
6	35	45	3.5	3.5
7	40	50	4.0	4.0
8	45	55	4.5	4.5
9	50	60	5.0	5.0
10	55	65	5.5	5.5

Table 47.

"A" open 27 deg. 71.5 deg. Fahr.  
 "B" open 32 deg. 2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	45	2.41
8	-----	20.66	-----	120	6.49
12	-----	20.40	-----	214	11.50
16	-----	19.33	-----	357	19.15
20	20.50	18.84	3.80	519	27.90
24	20.50	18.54	-----	610	32.70
28	20.50	18.54	-----	559	30.00
32	20.50	18.54	-----	540	29.00

Table 48.

"A" open 27 deg. 71.5 deg. Fahr.  
 "B" open 28 deg. 2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	44	2.36
8	-----	20.65	-----	116	6.22
12	-----	20.32	-----	214	11.50
16	-----	19.80	-----	352	18.90
20	20.54	18.90	3.80	520	27.90
24	20.54	18.81	-----	586	31.40
28	20.54	18.81	-----	517	27.75
32	20.54	18.81	-----	510	27.40

1900		1901		1902	
Jan	1	Jan	1	Jan	1
Feb	2	Feb	2	Feb	2
Mar	3	Mar	3	Mar	3
Apr	4	Apr	4	Apr	4
May	5	May	5	May	5
Jun	6	Jun	6	Jun	6
Jul	7	Jul	7	Jul	7
Aug	8	Aug	8	Aug	8
Sep	9	Sep	9	Sep	9
Oct	10	Oct	10	Oct	10
Nov	11	Nov	11	Nov	11
Dec	12	Dec	12	Dec	12

1903		1904		1905	
Jan	13	Jan	13	Jan	13
Feb	14	Feb	14	Feb	14
Mar	15	Mar	15	Mar	15
Apr	16	Apr	16	Apr	16
May	17	May	17	May	17
Jun	18	Jun	18	Jun	18
Jul	19	Jul	19	Jul	19
Aug	20	Aug	20	Aug	20
Sep	21	Sep	21	Sep	21
Oct	22	Oct	22	Oct	22
Nov	23	Nov	23	Nov	23
Dec	24	Dec	24	Dec	24

Table 49.

"A" open 27 deg.

71.5 deg. Fahr.

"B" open 24 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	45	2.41
8	-----	20.67	-----	118	6.34
12	-----	20.43	-----	227	12.20
16	20.70	19.80	4.20	360	19.30
20	-----	19.15	-----	499	26.80
24	20.60	19.07	-----	538	28.90
28	20.60	19.10	-----	462	24.80
32	20.60	19.20	-----	462	24.80

Table 50.

"A" open 27 deg.

71.5 deg. Fahr.

"B" open 20 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	45	2.41
8	-----	20.68	-----	117	6.28
12	20.81	20.37	4.32	228	12.75
16	-----	19.80	-----	347	18.60
20	-----	19.42	-----	496	26.60
24	-----	19.48	-----	426	22.85
28	20.68	19.50	-----	416	22.30
32	20.68	19.52	-----	410	22.00



Table 51.

"A" open 27 deg. 71.5 deg. Fahr.  
 "B" open 16 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	45	2.41
8	-----	20.69	-----	116	6.22
12	20.75	20.40	4.31	220	11.80
16	-----	19.95	-----	345	18.50
20	-----	19.88	-----	352	18.90
24	20.70	19.88	-----	350	18.80
28	-----	19.88	-----	350	18.80
32	20.70	19.88	-----	350	18.80

Table 52.

"A" open 27 deg. 71.5 deg. Fahr.  
 "B" open 12 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.80	-----	44	2.38
8	-----	20.70	-----	116	6.20
12	-----	20.40	-----	222	11.90
16	20.78	20.22	3.50	348	18.70
20	20.78	20.22	-----	279	14.95
24	20.78	20.22	-----	264	14.15
28	20.78	20.22	-----	260	13.95
32	20.78	20.22	-----	260	13.95

# Appendix

Table 1. Summary of the data used in the analysis.

Year	Country	Population	GDP	Urbanization	Life expectancy
1980	USA	226,542,879	249,100,000,000	73.4	74.7
1985	USA	236,819,368	266,800,000,000	74.1	76.3
1990	USA	248,709,873	285,400,000,000	74.8	77.0
1995	USA	265,959,511	305,400,000,000	75.5	77.7
2000	USA	281,421,906	321,400,000,000	76.2	78.4
2005	USA	295,732,236	339,100,000,000	76.9	79.1
2010	USA	309,292,328	359,100,000,000	77.6	79.8
2015	USA	322,732,236	381,100,000,000	78.3	80.5
2020	USA	336,172,236	406,100,000,000	79.0	81.2
2025	USA	349,612,236	433,100,000,000	79.7	81.9
2030	USA	363,052,236	462,100,000,000	80.4	82.6
2035	USA	376,492,236	493,100,000,000	81.1	83.3
2040	USA	389,932,236	526,100,000,000	81.8	84.0
2045	USA	403,372,236	561,100,000,000	82.5	84.7
2050	USA	416,812,236	598,100,000,000	83.2	85.4
2055	USA	430,252,236	637,100,000,000	83.9	86.1
2060	USA	443,692,236	678,100,000,000	84.6	86.8
2065	USA	457,132,236	721,100,000,000	85.3	87.5
2070	USA	470,572,236	766,100,000,000	86.0	88.2
2075	USA	484,012,236	813,100,000,000	86.7	88.9
2080	USA	497,452,236	862,100,000,000	87.4	89.6
2085	USA	510,892,236	913,100,000,000	88.1	90.3
2090	USA	524,332,236	966,100,000,000	88.8	91.0
2095	USA	537,772,236	1,021,100,000,000	89.5	91.7
2100	USA	551,212,236	1,078,100,000,000	90.2	92.4

# Appendix

Table 2. Summary of the data used in the analysis.

Year	Country	Population	GDP	Urbanization	Life expectancy
1980	USA	226,542,879	249,100,000,000	73.4	74.7
1985	USA	236,819,368	266,800,000,000	74.1	76.3
1990	USA	248,709,873	285,400,000,000	74.8	77.0
1995	USA	265,959,511	305,400,000,000	75.5	77.7
2000	USA	281,421,906	321,400,000,000	76.2	78.4
2005	USA	295,732,236	339,100,000,000	76.9	79.1
2010	USA	309,292,328	359,100,000,000	77.6	79.8
2015	USA	322,732,236	381,100,000,000	78.3	80.5
2020	USA	336,172,236	406,100,000,000	79.0	81.2
2025	USA	349,612,236	433,100,000,000	79.7	81.9
2030	USA	363,052,236	462,100,000,000	80.4	82.6
2035	USA	376,492,236	493,100,000,000	81.1	83.3
2040	USA	389,932,236	526,100,000,000	81.8	84.0
2045	USA	403,372,236	561,100,000,000	82.5	84.7
2050	USA	416,812,236	598,100,000,000	83.2	85.4
2055	USA	430,252,236	637,100,000,000	83.9	86.1
2060	USA	443,692,236	678,100,000,000	84.6	86.8
2065	USA	457,132,236	721,100,000,000	85.3	87.5
2070	USA	470,572,236	766,100,000,000	86.0	88.2
2075	USA	484,012,236	813,100,000,000	86.7	88.9
2080	USA	497,452,236	862,100,000,000	87.4	89.6
2085	USA	510,892,236	913,100,000,000	88.1	90.3
2090	USA	524,332,236	966,100,000,000	88.8	91.0
2095	USA	537,772,236	1,021,100,000,000	89.5	91.7
2100	USA	551,212,236	1,078,100,000,000	90.2	92.4



Table 53.

"A" open 27 deg. 71.5 deg. Fahr.  
 "B" open 8 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.81	-----	44	2.38
8	-----	20.68	-----	115	6.17
12	20.80	20.51	3.80	209	11.20
16	20.80	20.51	-----	209	11.20
20	20.80	20.51	-----	162	8.70
24	20.80	20.51	-----	162	8.70
28	20.80	20.51	-----	162	8.70
32	20.80	20.51	-----	162	8.70

Table 54.

"A" open 27 deg. 71.5 deg. Fahr.  
 "B" open 4 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	43	2.30
8	20.85	20.79	3.70	108	5.80
12	20.85	20.79	-----	80	4.30
16	20.85	20.79	-----	64	3.44
20	20.85	20.79	-----	64	3.44
24	20.85	20.79	-----	64	3.44
28	20.85	20.79	-----	64	3.44
32	20.85	20.79	-----	64	3.44

TABLE I					
1900			1901		
Year	Age	Sex	Year	Age	Sex
1900	10	M	1901	10	M
1900	10	F	1901	10	F
1900	10	M	1901	10	M
1900	10	F	1901	10	F
1900	10	M	1901	10	M
1900	10	F	1901	10	F
1900	10	M	1901	10	M
1900	10	F	1901	10	F
1900	10	M	1901	10	M
1900	10	F	1901	10	F

TABLE II					
1900			1901		
Year	Age	Sex	Year	Age	Sex
1900	10	M	1901	10	M
1900	10	F	1901	10	F
1900	10	M	1901	10	M
1900	10	F	1901	10	F
1900	10	M	1901	10	M
1900	10	F	1901	10	F
1900	10	M	1901	10	M
1900	10	F	1901	10	F
1900	10	M	1901	10	M
1900	10	F	1901	10	F

Table 55.

"A" open 23 deg. 71.5 deg. Fahr.  
 "B" open 36 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.75	-----	45	2.41
8	-----	20.51	-----	122	6.60
12	20.70	20.15	4.30	215	11.60
16	-----	19.20	-----	350	18.90
20	20.53	17.50	3.90	524	28.30
24	-----	15.35	3.45	688	37.15
28	20.30	15.15	-----	726	39.20
32	20.30	15.15	-----	680	36.70

Table 56.

"A" open 23 deg. 71.5 deg. Fahr.  
 "B" open 32 deg. 2 min. runs.

Valve	head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	45	2.40
8	-----	20.60	-----	115	6.17
12	-----	20.15	-----	211	11.30
16	-----	19.21	-----	356	19.10
20	20.60	18.32	3.32	496	26.60
24	-----	18.35	-----	468	25.10
28	-----	18.35	-----	461	24.20
32	-----	18.35	-----	446	23.90



Table 57.

"A" open 23 deg. 71.5 deg. Fahr.  
 "B" open 28 deg. 2 min. runs.

Valve G	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	44	2.38
8	20.82	20.60	4.40	117	6.28
12	-----	20.18	-----	232	12.45
16	20.70	19.27	4.10	360	19.30
20	-----	18.51	-----	496	26.60
24	20.63	18.48	-----	454	24.40
28	-----	18.48	-----	454	24.40
32	20.63	18.48	-----	454	24.40

Table 58.

"A" open 23 deg. 71.5 deg. Fahr.  
 "B" open 24 deg. 2 min. runs.

Valve Cq	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	44	2.38
8	-----	20.61	4.40	118	6.34
12	20.75	20.15	-----	214	11.50
16	-----	19.30	4.10	360	19.30
20	20.65	18.85	-----	482	25.85
24	-----	18.85	-----	422	22.60
28	-----	18.85	-----	398	21.35
32	-----	18.85	-----	400	21.45



Table 59.

"A" open 23 deg. 71.5 deg. Fahr.  
 "B" open 20 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	44	2.38
8	-----	20.57	4.40	118	6.34
12	20.80	20.20	-----	222	11.90
16	-----	19.37	4.10	354	19.00
20	20.70	19.20	-----	440	23.60
24	-----	19.20	-----	362	19.40
28	-----	19.20	-----	362	19.40
32	20.70	19.20	-----	362	19.40

Table 60

"A" open 23 deg. 71.5 deg. Fahr.  
 "B" open 16 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.80	-----	44	2.38
8	-----	20.59	-----	117	6.28
12	-----	20.12	-----	214	11.50
16	20.73	19.60	3.80	352	18.90
20	20.73	19.51	-----	360	19.30
24	20.73	19.51	-----	320	17.15
28	20.73	19.51	-----	320	17.15
32	20.73	19.51	-----	320	17.15

# Table 1

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction.

Concentration of the solution (M)	Rate of the reaction (mol/l·s)
0.1	0.001
0.2	0.002
0.3	0.003
0.4	0.004
0.5	0.005
0.6	0.006
0.7	0.007
0.8	0.008
0.9	0.009
1.0	0.010

# Table 2

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction.

Concentration of the solution (M)	Rate of the reaction (mol/l·s)
0.1	0.001
0.2	0.002
0.3	0.003
0.4	0.004
0.5	0.005
0.6	0.006
0.7	0.007
0.8	0.008
0.9	0.009
1.0	0.010



Table 61.

"A" open 23 deg. 71.5 deg. Fahr.  
 "B" open 12 deg. 2 min. runs.

Valve	Head of fuel			C.C.	Lb. per hr.
	C	L	F H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	44	2.38
8	-----	20.58	-----	118	6.33
12	20.80	20.10	4.24	215	11.60
16	20.78	20.00	-----	320	17.15
20	20.78	20.00	-----	252	13.50
24	20.78	20.00	-----	252	13.50
28	20.78	20.00	-----	252	13.50
32	20.78	20.00	-----	252	13.50

Table 62.

"A" open 23 deg. 71.5 deg. Fahr.  
 "B" open 8 deg. 2 min. runs.

Valve	Head of fuel			C.C.	Lb. per hr.
	C	L	F H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.80	-----	45	2.41
8	20.80	20.58	4.40	118	6.33
12	20.78	20.40	-----	222	11.90
16	20.78	20.40	-----	189	10.15
20	20.78	20.40	-----	158	8.49
24	20.78	20.40	-----	158	8.49
28	20.78	20.40	-----	158	8.49
32	20.78	20.40	-----	158	8.49

TABLE I					
Summary of the results of the experiments					
Run	Time	Temp.	Pressure	Volume	Weight
1	10	20	1.0	1.0	1.0
2	15	25	1.5	1.5	1.5
3	20	30	2.0	2.0	2.0
4	25	35	2.5	2.5	2.5
5	30	40	3.0	3.0	3.0
6	35	45	3.5	3.5	3.5
7	40	50	4.0	4.0	4.0
8	45	55	4.5	4.5	4.5
9	50	60	5.0	5.0	5.0
10	55	65	5.5	5.5	5.5

TABLE II					
Summary of the results of the experiments					
Run	Time	Temp.	Pressure	Volume	Weight
1	10	20	1.0	1.0	1.0
2	15	25	1.5	1.5	1.5
3	20	30	2.0	2.0	2.0
4	25	35	2.5	2.5	2.5
5	30	40	3.0	3.0	3.0
6	35	45	3.5	3.5	3.5
7	40	50	4.0	4.0	4.0
8	45	55	4.5	4.5	4.5
9	50	60	5.0	5.0	5.0
10	55	65	5.5	5.5	5.5

Table 63.

"A" open 23 deg. 71.5 deg. Fahr.  
 "B" open 4 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	2.25
4	-----	20.78	-----	42	6.01
8	20.83	20.78	3.65	112	3.52
12	20.83	20.78	-----	66	3.33
16	20.83	20.78	-----	62	3.33
20	20.83	20.78	-----	62	3.33
24	20.83	20.78	-----	62	3.33
28	20.83	20.78	-----	62	3.33
32	20.83	20.78	-----	62	3.33

Table 64.

"A" open 19 deg. 71.5 deg. Fahr.  
 "B" open 36 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	46	2.43
8	-----	20.42	-----	120	6.49
12	20.80	19.65	4.30	218	11.75
16	-----	18.00	3.90	355	19.20
20	20.40	14.80	3.20	514	27.70
24	20.40	12.00	-----	660	35.60
28	20.40	12.20	-----	645	34.85
32	20.40	12.50	-----	620	33.50



Table 65.

"A" open 19 deg. 71.5 deg. Fahr.  
 "B" open 32 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	44	2.38
8	20.80	20.39	4.40	118	6.33
12	-----	19.62	-----	214	11.50
16	20.70	18.20	4.10	368	19.75
20	20.68	17.70	-----	426	22.80
24	20.68	17.70	-----	378	20.15
28	20.68	17.70	-----	378	20.15
32	20.68	17.70	-----	378	20.15

Table 66.

"A" open 19 deg. 71.5 deg. Fahr.  
 "B" open 28 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.77	-----	43	2.31
8	-----	20.40	4.40	118	6.33
12	20.75	19.58	-----	214	11.50
16	20.70	18.00	4.05	360	19.30
20	-----	17.56	-----	450	24.15
24	20.63	17.56	-----	386	20.70
28	20.63	17.56	-----	386	20.70
32	20.63	17.56	-----	386	20.70

[illegible]

Table 67.

"A" open 19 deg. 71.5 deg. Fahr.  
 "B" open 24 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	44	2.38
8	-----	20.38	-----	119	6.39
12	20.65	19.60	4.30	214	11.50
16	-----	18.03	-----	358	19.20
20	20.67	17.65	-----	435	23.30
24	20.67	17.65	-----	378	20.30
28	20.67	17.65	-----	378	20.30
32	20.67	17.65	-----	378	20.30

Table 68.

"A" open 19 deg. 71.5 deg. Fahr.  
 "B" open 20 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.77	-----	44	2.38
8	-----	20.39	-----	119	6.39
12	-----	19.60	-----	230	12.28
16	20.70	18.20	4.00	350	18.90
20	20.68	18.00	-----	412	22.10
24	20.68	18.00	-----	346	18.55
28	20.68	18.00	-----	346	18.55
32	20.68	18.00	-----	346	18.55





Table 69.

"A" open 19 deg. 71.5 deg. Fahr.  
 "B" open 16 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.78	-----	43	2.31
8	-----	20.40	-----	118	6.33
12	20.80	19.64	4.35	216	11.60
16	-----	18.65	-----	346	18.55
20	20.72	18.54	-----	355	19.05
24	-----	18.54	-----	304	16.30
28	20.70	18.60	-----	302	16.20
32	20.70	18.60	-----	302	16.20

Table 70.

"A" open 19 deg. 74 deg. Fahr.  
 "B" open 12 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.77	-----	45	2.40
8	-----	20.40	-----	115	6.15
12	20.72	19.52	4.22	226	12.05
16	-----	19.29	-----	329	17.60
20	20.72	19.29	-----	258	13.80
24	20.72	19.29	-----	258	13.80
28	20.72	19.29	-----	258	13.80
32	20.72	19.29	-----	258	13.80

# Table 1

Summary of the results of the experiments conducted on the effect of the concentration of the solution on the rate of reaction.

Concentration of solution (M)	Time taken for reaction to complete (s)	Rate of reaction (1/s)	Order of reaction
0.1	120	0.0083	1
0.2	60	0.0167	1
0.3	40	0.0250	1
0.4	30	0.0333	1
0.5	24	0.0417	1
0.6	20	0.0500	1
0.7	17	0.0588	1
0.8	15	0.0667	1
0.9	13	0.0769	1
1.0	12	0.0833	1

# Table 2

Summary of the results of the experiments conducted on the effect of the temperature on the rate of reaction.

Temperature (°C)	Time taken for reaction to complete (s)	Rate of reaction (1/s)	Order of reaction
20	120	0.0083	1
25	60	0.0167	1
30	40	0.0250	1
35	30	0.0333	1
40	24	0.0417	1
45	20	0.0500	1
50	17	0.0588	1
55	15	0.0667	1
60	13	0.0769	1
65	12	0.0833	1

Table 71.

"A" open 19 deg. 74 deg. Fahr.

"B" open 8 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.77	-----	44	2.35
8	20.80	20.40	4.37	117	6.25
12	20.78	20.17	-----	217	11.60
16	20.78	20.17	-----	181	9.68
20	20.78	20.17	-----	158	8.45
24	20.78	20.17	-----	146	7.80
28	20.78	20.17	-----	146	7.80
32	20.78	20.17	-----	146	7.80

Table 72.

"A" open 19 deg. 74 deg. Fahr.

"B" open 4 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.79	-----	41	2.19
8	20.82	20.70	-----	102	5.45
12	20.82	20.70	-----	65	3.47
16	20.82	20.70	-----	65	3.47
20	20.82	20.70	-----	65	3.47
24	20.82	20.70	-----	65	3.47
28	20.82	20.70	-----	65	3.47
32	20.82	20.70	-----	65	3.47

TABLE I		TABLE II	
Year	Value	Year	Value
1900	100	1900	100
1901	105	1901	105
1902	110	1902	110
1903	115	1903	115
1904	120	1904	120
1905	125	1905	125
1906	130	1906	130
1907	135	1907	135
1908	140	1908	140
1909	145	1909	145
1910	150	1910	150

TABLE III		TABLE IV	
Year	Value	Year	Value
1900	100	1900	100
1901	105	1901	105
1902	110	1902	110
1903	115	1903	115
1904	120	1904	120
1905	125	1905	125
1906	130	1906	130
1907	135	1907	135
1908	140	1908	140
1909	145	1909	145
1910	150	1910	150

Table 73.

"A" open 15 deg. 71.5 deg. Fahr.  
 "B" open 36 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.73	-----	44	2.38
8	-----	19.42	-----	121	6.54
12	20.80	18.10	4.30	218	11.75
16	20.70	14.60	4.13	350	18.90
20	20.60	10.10	-----	493	26.60
24	20.60	10.10	-----	475	25.65
28	20.60	10.40	-----	460	24.85
32	20.60	10.60	-----	450	24.30

Table 74.

"A" open 15 deg. 74 deg. Fahr.  
 "B" open 32 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.70	-----	44	2.35
8	20.79	19.95	4.39	116	6.20
12	-----	18.10	-----	222	11.85
16	20.70	15.20	-----	346	18.65
20	20.70	15.10	-----	365	19.50
24	20.70	15.35	-----	340	18.15
28	20.70	15.50	-----	336	17.95
32	20.70	15.60	-----	333	17.80

# Table 1

Table 1. Summary of the results of the regression analysis for the dependent variable  $Y$  (the dependent variable is the same as in Table 1 of the main text).

Variable	Mean	Standard Deviation	Minimum	Maximum	Range
$Y$	1.00	1.00	0.00	2.00	2.00
$X_1$	1.00	1.00	0.00	2.00	2.00
$X_2$	1.00	1.00	0.00	2.00	2.00
$X_3$	1.00	1.00	0.00	2.00	2.00
$X_4$	1.00	1.00	0.00	2.00	2.00
$X_5$	1.00	1.00	0.00	2.00	2.00
$X_6$	1.00	1.00	0.00	2.00	2.00
$X_7$	1.00	1.00	0.00	2.00	2.00
$X_8$	1.00	1.00	0.00	2.00	2.00
$X_9$	1.00	1.00	0.00	2.00	2.00
$X_{10}$	1.00	1.00	0.00	2.00	2.00

# Table 2

Table 2. Summary of the results of the regression analysis for the dependent variable  $Y$  (the dependent variable is the same as in Table 1 of the main text).

Variable	Mean	Standard Deviation	Minimum	Maximum	Range
$Y$	1.00	1.00	0.00	2.00	2.00
$X_1$	1.00	1.00	0.00	2.00	2.00
$X_2$	1.00	1.00	0.00	2.00	2.00
$X_3$	1.00	1.00	0.00	2.00	2.00
$X_4$	1.00	1.00	0.00	2.00	2.00
$X_5$	1.00	1.00	0.00	2.00	2.00
$X_6$	1.00	1.00	0.00	2.00	2.00
$X_7$	1.00	1.00	0.00	2.00	2.00
$X_8$	1.00	1.00	0.00	2.00	2.00
$X_9$	1.00	1.00	0.00	2.00	2.00
$X_{10}$	1.00	1.00	0.00	2.00	2.00

Table 75.

"A" open 15 deg. 74 deg. Fahr.  
 "B" open 28 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.69	-----	44	2.35
8	-----	20.14	-----	116	6.20
12	20.70	18.33	4.39	220	11.75
16	20.70	16.20	3.80	338	18.05
20	20.70	16.20	-----	336	17.95
24	20.70	16.30	-----	316	16.90
28	20.70	16.35	-----	308	16.45
32	20.70	16.40	-----	298	15.90

Table 76.

"A" open 15 deg. 74 deg. Fahr.  
 "B" open 24 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.70	-----	43	2.30
8	-----	20.00	-----	117	6.25
12	20.70	18.50	4.30	214	11.45
16	20.70	16.70	-----	346	18.50
20	20.70	16.60	-----	327	17.45
24	20.70	16.60	-----	294	15.70
28	20.70	16.63	-----	294	15.70
32	20.70	16.67	-----	294	15.70





Table 77.

"A" open 15 deg.                      74 deg. Fahr.  
 "B" open 20 deg.                      2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.68	-----	44	2.35
8	-----	19.97	-----	114	6.10
12	20.73	18.00	4.30	216	11.55
16	20.73	17.22	-----	333	17.80
20	20.73	17.22	-----	292	15.60
24	20.73	17.26	-----	268	14.30
28	20.73	17.29	-----	268	14.30
32	20.73	17.32	-----	268	14.30

Table 78.

"A" open 15 deg.                      74 deg. Fahr.  
 "B" open 16 deg.                      2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.69	-----	44	2.35
8	-----	19.92	-----	116	6.20
12	-----	18.30	-----	224	11.95
16	20.70	17.72	3.35	329	17.60
20	20.70	17.70	-----	254	13.55
24	20.70	17.75	-----	250	13.35
28	20.70	17.80	-----	250	13.35
32	20.70	17.84	-----	250	13.35

# Table 1

Summary of the results of the analysis of variance for the effect of the treatment on the response variable.

Treatment	Response Variable	Mean	Standard Error	95% CI	p-value
Control	Yield	1.2	0.1	1.0 - 1.4	0.05
T1	Yield	1.5	0.1	1.3 - 1.7	0.01
T2	Yield	1.8	0.1	1.6 - 2.0	0.001
T3	Yield	2.1	0.1	1.9 - 2.3	0.0001
T4	Yield	2.4	0.1	2.2 - 2.6	0.00001
T5	Yield	2.7	0.1	2.5 - 2.9	0.000001
T6	Yield	3.0	0.1	2.8 - 3.2	0.0000001
T7	Yield	3.3	0.1	3.1 - 3.5	0.00000001
T8	Yield	3.6	0.1	3.4 - 3.8	0.000000001
T9	Yield	3.9	0.1	3.7 - 4.1	0.0000000001
T10	Yield	4.2	0.1	4.0 - 4.4	0.00000000001

# Table 2

Summary of the results of the analysis of variance for the effect of the treatment on the response variable.

Treatment	Response Variable	Mean	Standard Error	95% CI	p-value
Control	Yield	1.2	0.1	1.0 - 1.4	0.05
T1	Yield	1.5	0.1	1.3 - 1.7	0.01
T2	Yield	1.8	0.1	1.6 - 2.0	0.001
T3	Yield	2.1	0.1	1.9 - 2.3	0.0001
T4	Yield	2.4	0.1	2.2 - 2.6	0.00001
T5	Yield	2.7	0.1	2.5 - 2.9	0.000001
T6	Yield	3.0	0.1	2.8 - 3.2	0.0000001
T7	Yield	3.3	0.1	3.1 - 3.5	0.00000001
T8	Yield	3.6	0.1	3.4 - 3.8	0.000000001
T9	Yield	3.9	0.1	3.7 - 4.1	0.0000000001
T10	Yield	4.2	0.1	4.0 - 4.4	0.00000000001

Table 79.

"A" open 15 deg. 74 deg. Fahr.  
 "B" open 12 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.69	0	0.00
4	-----	20.68	-----	44	2.35
8	-----	20.00	-----	117	6.25
12	-----	18.65	-----	220	11.75
16	20.70	18.50	-----	274	14.65
20	20.70	18.55	-----	212	11.30
24	20.70	18.58	-----	208	11.10
28	20.70	18.60	-----	295	10.40
32	20.70	18.65	-----	195	10.40

Table 80.

"A" open 15 deg. 74 deg. Fahr.  
 "B" open 8 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.69	-----	44	2.35
8	-----	19.98	-----	117	6.25
12	20.77	19.60	3.80	206	11.00
16	20.77	19.60	-----	160	8.55
20	20.77	19.60	-----	142	7.59
24	20.77	19.60	-----	142	7.59
28	20.77	19.60	-----	142	7.59
32	20.77	19.60	-----	142	7.59

# TABLE I

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction.

Concentration of the solution		Rate of the reaction		Time	
g/l	ml	g/l	ml	g/l	ml
1.0	10	1.0	10	1.0	10
2.0	10	2.0	10	2.0	10
3.0	10	3.0	10	3.0	10
4.0	10	4.0	10	4.0	10
5.0	10	5.0	10	5.0	10
6.0	10	6.0	10	6.0	10
7.0	10	7.0	10	7.0	10
8.0	10	8.0	10	8.0	10
9.0	10	9.0	10	9.0	10
10.0	10	10.0	10	10.0	10

# TABLE II

Summary of the results of the experiments on the effect of the concentration of the solution on the rate of the reaction.

Concentration of the solution		Rate of the reaction		Time	
g/l	ml	g/l	ml	g/l	ml
1.0	10	1.0	10	1.0	10
2.0	10	2.0	10	2.0	10
3.0	10	3.0	10	3.0	10
4.0	10	4.0	10	4.0	10
5.0	10	5.0	10	5.0	10
6.0	10	6.0	10	6.0	10
7.0	10	7.0	10	7.0	10
8.0	10	8.0	10	8.0	10
9.0	10	9.0	10	9.0	10
10.0	10	10.0	10	10.0	10

Table 81.

"A" open 15 deg.

74 deg. Fahr.

"B" open 4 deg.

2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	20.82	20.60	4.20	42	2.24
8	20.82	20.60	----	110	5.87
12	20.82	20.60	----	76	4.06
16	20.82	20.602	----	62	3.31
20	20.82	20.60	----	62	3.31
24	20.82	20.60	----	62	3.31
28	20.82	20.60	----	62	3.31
32	20.82	20.60	----	62	3.31

Table 82.

"A" open 11 deg.

74 deg. Fahr.

"B" open 36 deg.

2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.48	----	44	2.38
8	20.80	18.66	4.40	121	6.50
12	20.75	14.50	----	216	11.64
16	20.75	8.10	----	337	18.20
20	20.75	7.90 <sub>q</sub>	----	325	17.55
24	20.75	8.10	----	309	16.70
28	20.75	8.20	----	304	16.45
32	20.75	8.30	-----	302	16.30

# Table 1

Summary of the results of the regression analysis for the dependent variable  $Y_i$  (the number of children in the household) and the independent variables  $X_i$  (the number of children in the household) and  $Z_i$  (the number of children in the household).

Variable	Mean	Standard Deviation	Minimum	Maximum	Range
$Y_i$	1.5	1.0	0	3	3
$X_i$	1.5	1.0	0	3	3
$Z_i$	1.5	1.0	0	3	3
$Y_i$	1.5	1.0	0	3	3
$X_i$	1.5	1.0	0	3	3
$Z_i$	1.5	1.0	0	3	3
$Y_i$	1.5	1.0	0	3	3
$X_i$	1.5	1.0	0	3	3
$Z_i$	1.5	1.0	0	3	3

# Table 2

Summary of the results of the regression analysis for the dependent variable  $Y_i$  (the number of children in the household) and the independent variables  $X_i$  (the number of children in the household) and  $Z_i$  (the number of children in the household).

Variable	Mean	Standard Deviation	Minimum	Maximum	Range
$Y_i$	1.5	1.0	0	3	3
$X_i$	1.5	1.0	0	3	3
$Z_i$	1.5	1.0	0	3	3
$Y_i$	1.5	1.0	0	3	3
$X_i$	1.5	1.0	0	3	3
$Z_i$	1.5	1.0	0	3	3
$Y_i$	1.5	1.0	0	3	3
$X_i$	1.5	1.0	0	3	3
$Z_i$	1.5	1.0	0	3	3

Table 83.

"A" open 11 deg. 74 deg. Fahr.  
 "B" open 32 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.48	-----	44	2.35
8	20.78	18.63	4.40	122	6.52
12	-----	14.00	-----	216	11.55
16	20.70	14.00	-----	252	13.45
20	20.70	14.00	-----	218	11.65
24	20.70	14.00	-----	218	11.65
28	20.70	14.00	-----	218	11.65
32	20.70	14.00	-----	218	11.65

Table 84.

"A" open 11 deg. 74 deg. Fahr.  
 "B" open 28 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.49	-----	44	2.35
8	20.78	18.63	4.40	115	6.15
12	-----	14.60	-----	210	11.20
16	20.70	14.25	-----	248	13.25
20	20.70	14.30	-----	212	11.30
24	20.70	14.40	-----	208	11.10
28	20.70	14.50	-----	208	11.10
32	20.70	14.50	-----	208	11.10

# Table 1

Table 1: Summary of the data used in the study.

Variable	Unit	Mean	Std. Dev.	Min.	Max.
Age	Years	35.2	12.5	18	65
Gender	Male/Female	50.0/50.0	0.0/0.0	0	1
Education	Years	12.8	2.1	8	16
Income	Dollars	45,000	15,000	20,000	80,000
Health	Good/Bad	60.0/40.0	0.0/0.0	0	1
Marital Status	Married/Single	70.0/30.0	0.0/0.0	0	1
Employment	Employed/Unemployed	80.0/20.0	0.0/0.0	0	1
Home Ownership	Owned/Rent	65.0/35.0	0.0/0.0	0	1
Vehicle Ownership	Owned/No Vehicle	75.0/25.0	0.0/0.0	0	1
Life Satisfaction	1-5	3.2	0.8	1	5

# Table 2

Table 2: Summary of the data used in the study.

Variable	Unit	Mean	Std. Dev.	Min.	Max.
Age	Years	35.2	12.5	18	65
Gender	Male/Female	50.0/50.0	0.0/0.0	0	1
Education	Years	12.8	2.1	8	16
Income	Dollars	45,000	15,000	20,000	80,000
Health	Good/Bad	60.0/40.0	0.0/0.0	0	1
Marital Status	Married/Single	70.0/30.0	0.0/0.0	0	1
Employment	Employed/Unemployed	80.0/20.0	0.0/0.0	0	1
Home Ownership	Owned/Rent	65.0/35.0	0.0/0.0	0	1
Vehicle Ownership	Owned/No Vehicle	75.0/25.0	0.0/0.0	0	1
Life Satisfaction	1-5	3.2	0.8	1	5



Table 85.

"A" open 11 deg. 74 deg. Fahr.  
 "B" open 24 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.50	-----	44	2.35
8	-----	18.65	-----	115	6.15
12	-----	14.85	-----	213	11.40
16	20.72	14.30	-----	290	15.50
20	20.72	14.30	-----	223	11.90
24	20.72	14.40	-----	211	11.25
28	20.72	14.50	-----	209	11.15
32	20.72	14.50	-----	207	11.05

Table 86.

"A" open 11 deg. 74 deg. Fahr.  
 "B" open 20 deg. 2 min. runs.

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
4	-----	20.49	-----	43	2.30
8	20.78	18.60	4.40	115	6.15
12	-----	15.03	-----	212	11.30
16	-----	14.71	-----	279	14.90
20	-----	14.78	-----	204	10.90
24	20.70	14.78	-----	204	10.90
28	20.70	14.78	-----	204	10.90
32	20.70	14.78	-----	204	10.90



Table 87.

"A" open 11 deg. 74 deg. Fahr.  
 "B" open 16 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	40	0.00
4	-----	20.48	-----	44	2.35
8	-----	18.65	-----	116	6.20
12	-----	15.40	-----	207	11.05
16	20.70	15.20	-----	260	13.90
20	20.70	15.20	0----	196	10.45
24	20.70	15.25	-----	192	10.25
28	20.70	15.28	-----	192	10.25
32	20.70	15.33	-----	192	10.25

Table 88

"A" open 11 deg. 74 deg. Fahr.  
 "B" open 12 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.49	-----	43	2.30
8	20.78	18.45	-----	116	6.20
12	20.78	16.40	-----	228	12.20
16	20.78	16.30	-----	220	11.75
20	20.78	16.35	-----	177	9.46
24	20.78	16.40	-----	173	9.25
28	20.78	16.40	-----	170	9.09
32	20.78	16.40	-----	170	9.09



Table 89.

"A" open 11 deg.

74 deg. Fahr.

"B" open 8 deg.

2 min. runs.

Valve	Head of fuel			C.C.	Lb. per hr.
C	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.50	-----	44	2.35
8	-----	18.66	-----	114	10.70
12	20.78	18.15	-----	200	7.48
16	20.78	18.12	-----	140	6.95
20	20.78	18.12	-----	130	6.95
24	20.78	18.12	-----	130	6.95
28	20.78	18.12	-----	130	6.95
32	20.78	18.12	-----	130	6.95

Table 90.

"A" open 11 deg.

74 deg. Fahr.

"B" open 4 deg.

2 min. runs.

Valve	Head of fuel			C.C.	Lb. per hr.
C	L	F	H		
0	20.90	20.90	4.60	0	0.00
4	-----	20.25	-----	41	2.19
8	20.82	20.25	-----	104	5.56
12	20.80	20.25	-----	64	3.42
16	20.80	20.25	-----	60	3.21
20	20.80	20.25	-----	60	3.21
24	20.80	20.25	-----	60	3.21
28	20.80	20.25	-----	60	3.21
32	20.80	20.25	-----	60	3.21

# Table 1

Table 1 shows the results of the regression analysis for the dependent variable  $Y$  and the independent variable  $X$ .

Variable	Mean	Std. Dev.	Minimum	Maximum	Skewness
$Y$	1.00	.00	1.00	1.00	.00
$X$	1.00	.00	1.00	1.00	.00
$Y^2$	1.00	.00	1.00	1.00	.00
$X^2$	1.00	.00	1.00	1.00	.00
$YX$	1.00	.00	1.00	1.00	.00
$Y^3$	1.00	.00	1.00	1.00	.00
$X^3$	1.00	.00	1.00	1.00	.00
$Y^4$	1.00	.00	1.00	1.00	.00
$X^4$	1.00	.00	1.00	1.00	.00
$Y^5$	1.00	.00	1.00	1.00	.00
$X^5$	1.00	.00	1.00	1.00	.00

# Table 2

Table 2 shows the results of the regression analysis for the dependent variable  $Y$  and the independent variable  $X$ .

Variable	Mean	Std. Dev.	Minimum	Maximum	Skewness
$Y$	1.00	.00	1.00	1.00	.00
$X$	1.00	.00	1.00	1.00	.00
$Y^2$	1.00	.00	1.00	1.00	.00
$X^2$	1.00	.00	1.00	1.00	.00
$YX$	1.00	.00	1.00	1.00	.00
$Y^3$	1.00	.00	1.00	1.00	.00
$X^3$	1.00	.00	1.00	1.00	.00
$Y^4$	1.00	.00	1.00	1.00	.00
$X^4$	1.00	.00	1.00	1.00	.00
$Y^5$	1.00	.00	1.00	1.00	.00
$X^5$	1.00	.00	1.00	1.00	.00

Table 91.

"A" open 7 deg.

71.5 deg. Fahr.

"B" open 36 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.000
2	-----	20.60	-----	19	1.020
4	-----	19.40	-----	44	2.380
6	-----	17.30	-----	76	4.110
8	20.80	12.30	4.35	121	6.540

Table 92.

"A" open 7 deg.

66 deg. Fahr.

"B" open 32deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.000
2	-----	20.59	-----	18	0.970
4	-----	19.46	-----	44	2.370
6	-----	17.25	-----	77	4.150
8	20.78	12.30	4.25	122	6.570





Table 93.

"A" open 7 deg.

66 deg. Fahr.

"B" open 28 deg.

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
2	20.85	20.58	4.50	19	1.02
4	*----	19.45	----	44	2.37
6	----	17.28	----	76	4.10
8	20.80	12.30	4.35	123	6.53

Table 94.

"A" open 7 deg.

66 deg. Fahr.

"B" open 24 deg. F

2 min. runs

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0	0.00
2	----	20.58	----	19	1.02
4	----	19.43	----	44	2.37
6	----	17.28	----	76	4.10
8	----	12.28	----	123	6.53



Table 95.

"A" open 7 deg. 66 deg. Fahr.  
 "B" open 20 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
2	-----	20.57	-----	18	0.97
4	-----	19.44	-----	44	2.37
6	-----	17.30	-----	77	4.15
8	-----	12.30	-----	122	6.57

Table 96.

"A" open 7 deg. 66 deg. Fahr.  
 "B" open 16 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
2	-----	20.55	-----	19	1.02
4	-----	19.46	-----	44	2.37
6	-----	17.30	-----	77	4.15
8	20.80	12.30	4.35	123	6.55



Table 97.

"A" open 7 deg. 66 deg. Fahr.  
 "B" open 12 deg. 2 min. runs

Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
2	-----	20.55	-----	19	1.02
4	-----	19.50	-----	43	2.31
6	-----	17.30	-----	77	4.15
8	20.80	12.30	4.35	122	6.57

Table 98

"A" open 7 deg. 66 deg. Fahr.  
 "B" open 8 deg. 2 min. runs

Valve	Head of fuel				LB.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
2	-----	20.50	-----	19	1.02
4	-----	19.47	-----	44	2.37
6	-----	16.75	-----	78	4.20
8	20.80	12.30	4.35	124	6.68
10	20.75	10.30	-----	166	8.95
14	20.75	10.30	-----	142	7.65
18	20.75	10.30	-----	128	6.90
26	20.75	10.30	-----	128	6.90
32	20.75	10.30	-----	128	6.90



Table 99.

"A" open 7 deg. 66 deg. Fahr.  
 "B" open 4 deg. 2 min. runs.

Valve	Head of fuel			Lb.	
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.00
2	-----	20.75	-----	19	1.02
4	20.85	19.20	4.40	44	2.37
6	20.80	18.10	-----	78	4.20
8	20.80	17.90	-----	113	6.08
10	20.80	17.90	-----	83	4.47
12	20.80	17.90	-----	74	3.98
18	20.80	17.90	-----	74	3.98
24	20.80	17.90	-----	74	3.98
32	20.80	17.90	-----	74	3.98

Table 100.

"A" open 3 deg. 66 deg. Fahr.  
 "B" open 36 deg. 2 min. runs.

Valve	Head of fuel			Lb.	
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0.00	0.000
1	-----	20.84	-----	6	0.324
2	-----	19.92	-----	13	0.701
3	-----	13.60	-----	31	1.670

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Table 101.

"A" open 3 deg. 66 deg. Fahr.  
 "B" open 32 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0.0	0.000
1	-----	20.84	-----	6.0	0.324
2	-----	19.92	-----	13.0	0.701
3	-----	13.60	-----	31.5	1.695

Table 102.

"A" open 3 deg. 66 deg. Fahr.  
 "B" open 28 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0.0	0.000
1	-----	20.84	-----	5.5	0.296
2	-----	19.92	-----	13.0	0.701
3	-----	13.59	-----	31.0	1.670

Table 103.

"A" open 3 deg. 66 deg. Fahr.  
 "B" open 24 deg... 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0.0	0.000
1	-----	20.82	-----	6.0	0.324
2	-----	19.92	-----	13.0	0.701
3	-----	13.60	-----	30.5	1.645



Table 104.

"A" open 3 deg. 66 deg. Fahr.  
 "B" open 20 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0.0	0.000
1	-----	20.85	-----	5.5	0.296
2	-----	19.93	-----	12.5	0.674
3	-----	13.61	-----	31.0	1.670

Table 105.

"A" open 3 deg. 66 deg. Fahr.  
 "B" open 16 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0.0	0.000
1	-----	20.84	-----	6.0	0.324
2	-----	19.94	-----	13.0	0.701
3	-----	13.60	-----	31.0	1.670

Table 106.

"A" open 3 deg. 66 deg. Fahr.  
 "B" open 12 deg. 2 min. runs.

Valve C	Head of fuel			C.C.	Lb. per hr.
	L	F	H		
0	20.90	20.90	4.60	0.0	0.000
1	-----	20.84	-----	6.0	0.324
2	-----	19.92	-----	13.0	0.701
3	-----	13.60	-----	31.0	1.670



Table 107.

		"A" open 3 deg.		66 deg. Fahr.	
		"B" open 8 deg.		2 min. runs.	
Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0.0	0.000
1	-----	20.85	-----	5.5	0.296
2	-----	19.91	-----	13.5	0.728
3	-----	13.58	-----	30.5	1.645

Table 108.

		"A" open 3 deg.		66 deg. Fahr.	
		"B" open 4 deg.		2 min. runs	
Valve	Head of fuel				Lb.
C	L	F	H	C.C.	per hr.
0	20.90	20.90	4.60	0	0.000
1	-----	20.83	-----	6	0.324
2	-----	20.62	-----	13	0.701
3	-----	20.35	-----	30	1.615
4	-----	19.00	-----	34	1.830
5	-----	12.00	-----	40	2.160
6	-----	8.10	-----	42	2.260
8	-----	8.10	-----	42	2.260
16	-----	8.10	-----	42	2.260
32	-----	8.10	-----	42	2.260

1900-1901  
 1902-1903  
 1904-1905

Year	1900-1901	1902-1903	1904-1905
1	---	---	---
2	---	---	---
3	---	---	---

1906-1907  
 1908-1909  
 1910-1911

Year	1906-1907	1908-1909	1910-1911
4	---	---	---
5	---	---	---
6	---	---	---
7	---	---	---
8	---	---	---
9	---	---	---
10	---	---	---

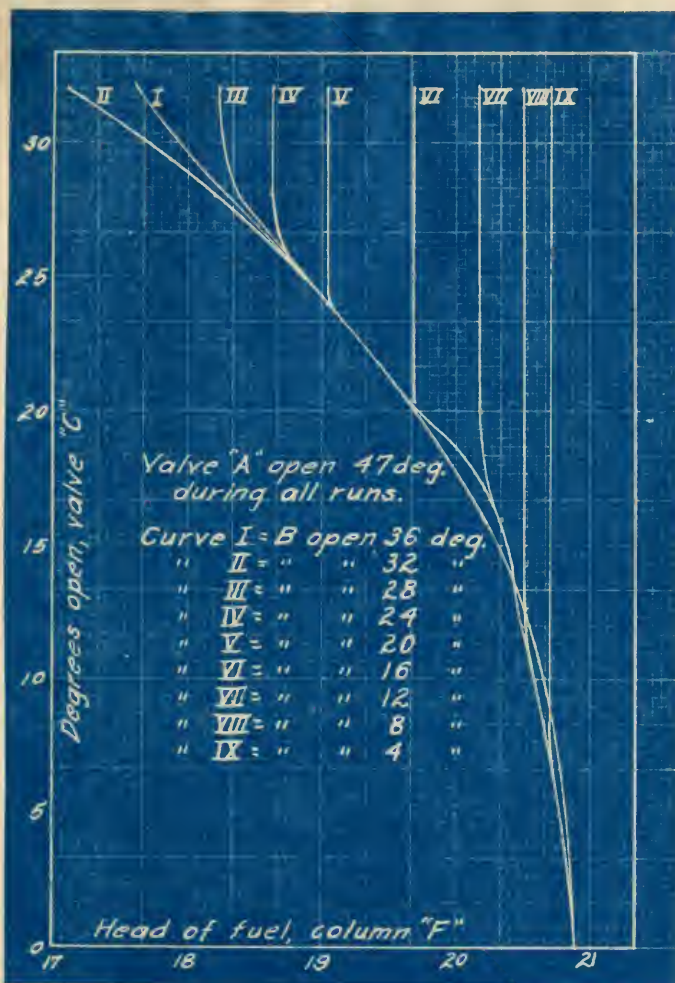


Fig. 1.





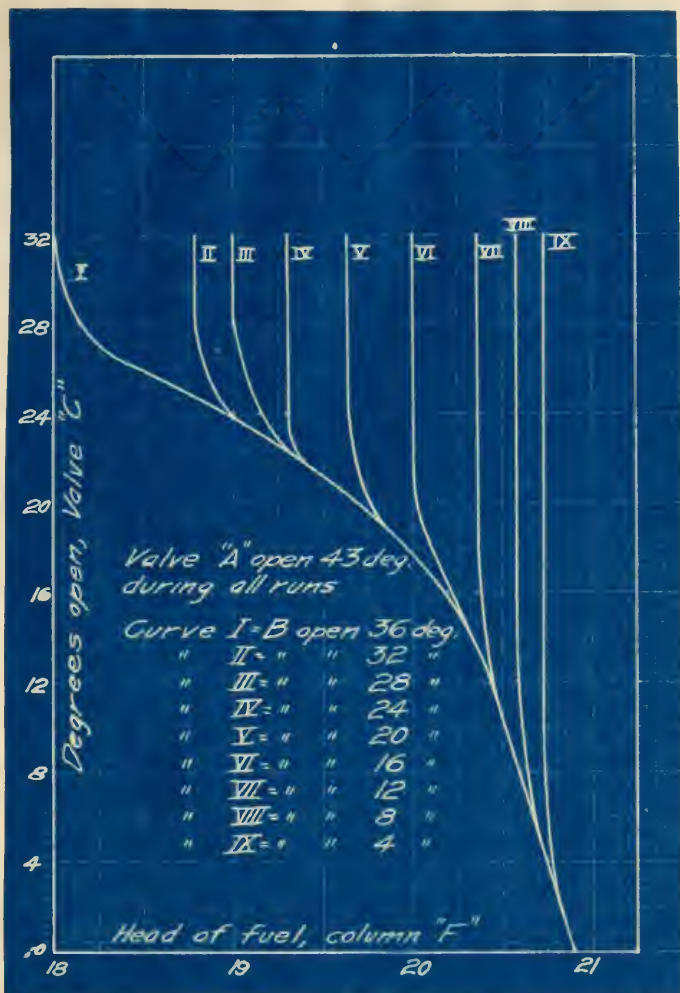


Fig. 2.



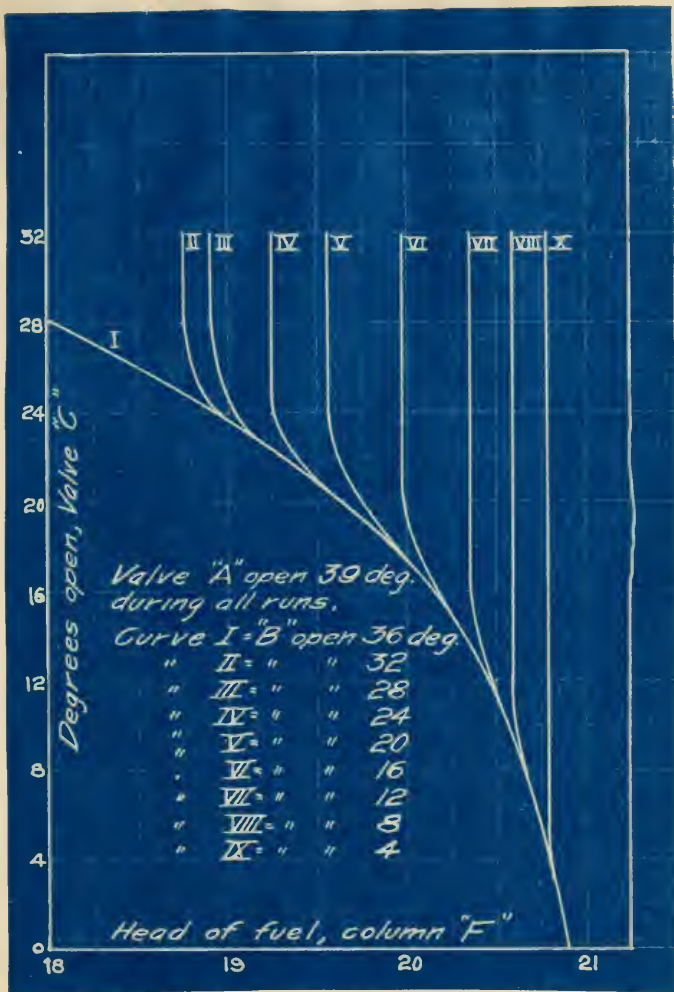


Fig. 3.



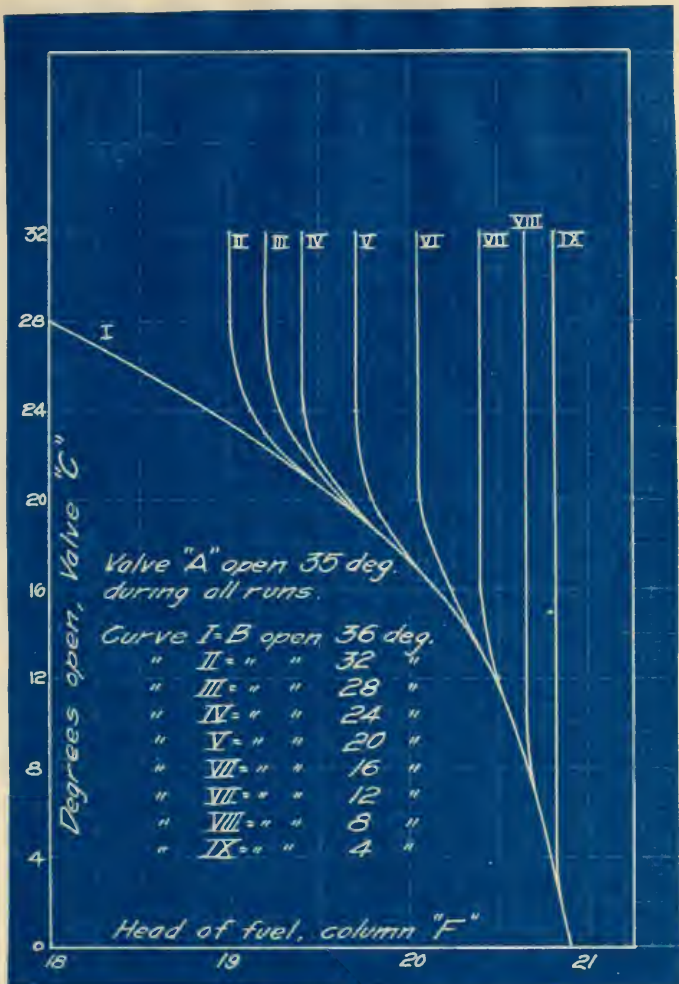


Fig. 4.



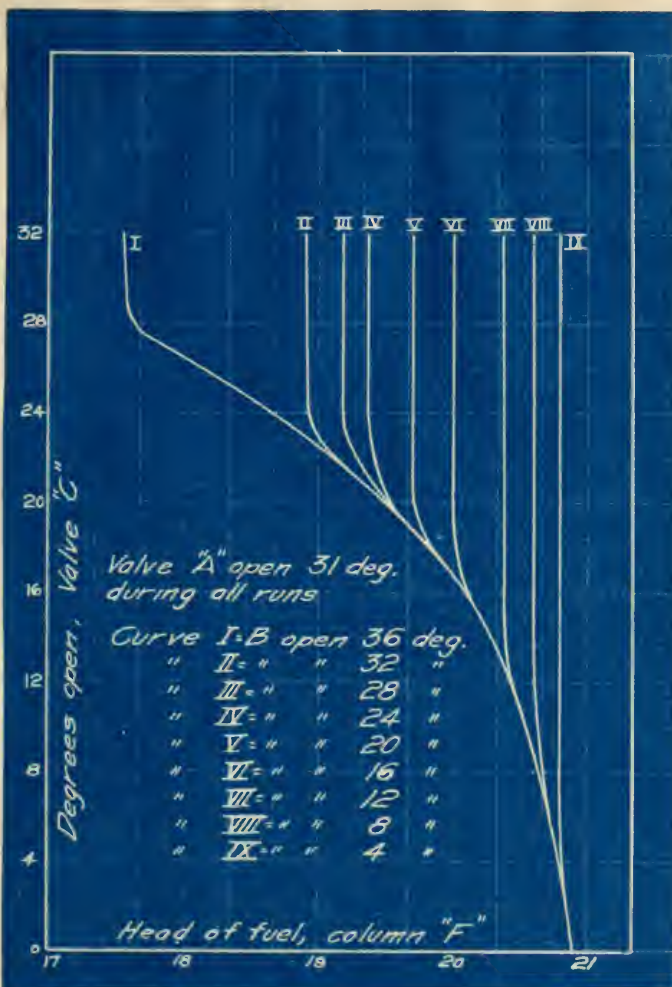


Fig. 5.





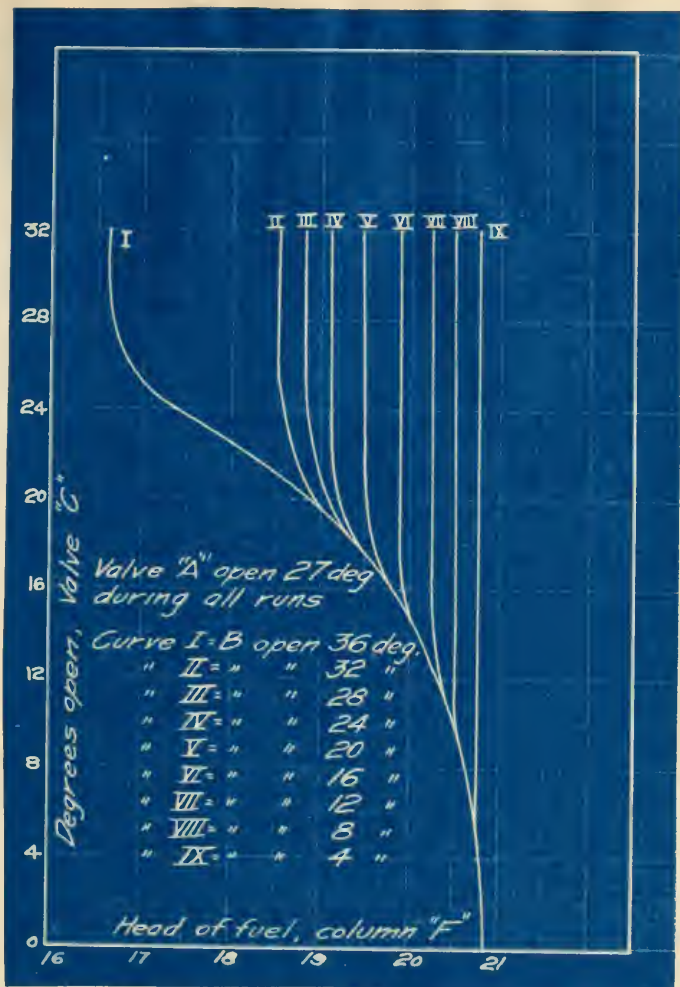


Fig. 6.



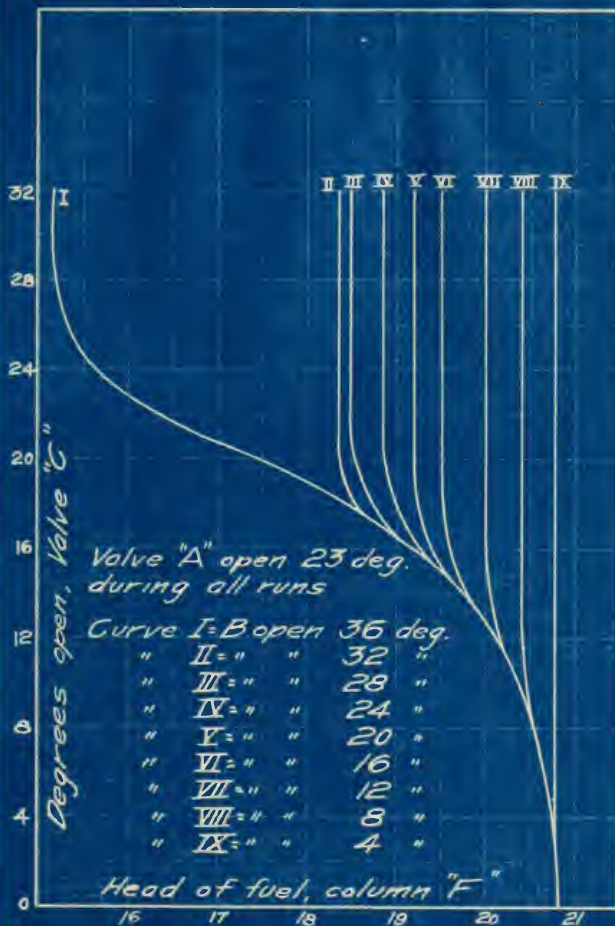


Fig. 7.



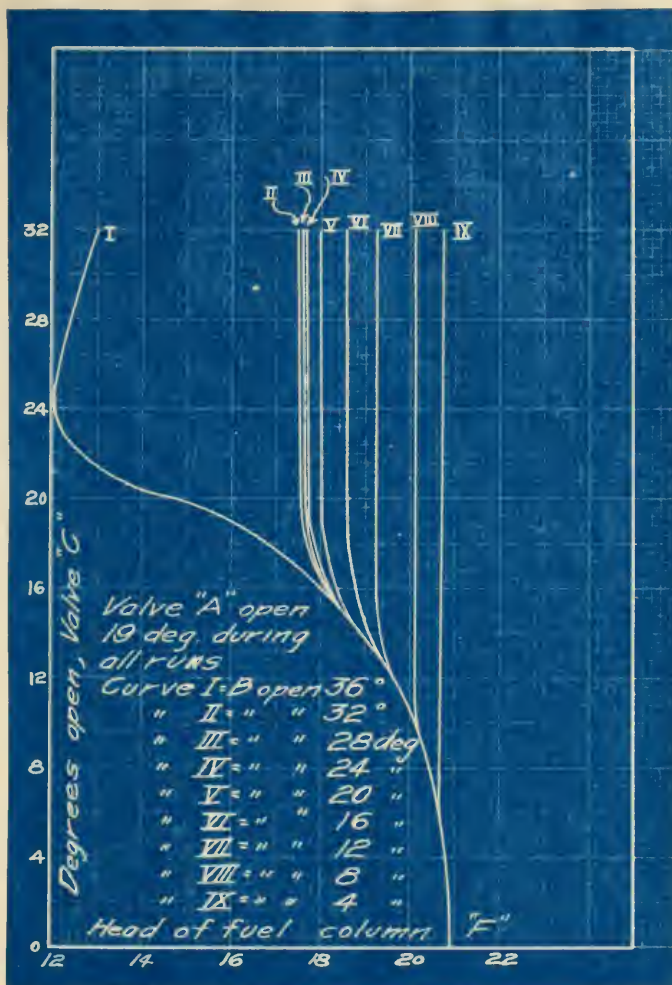


Fig. 8.



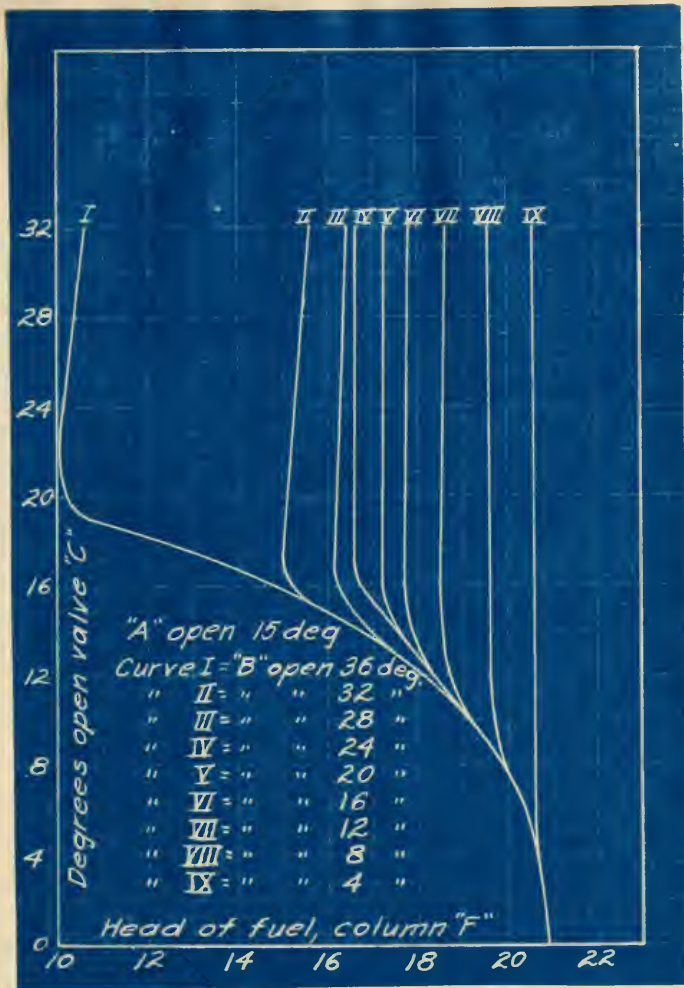


Fig. 9.





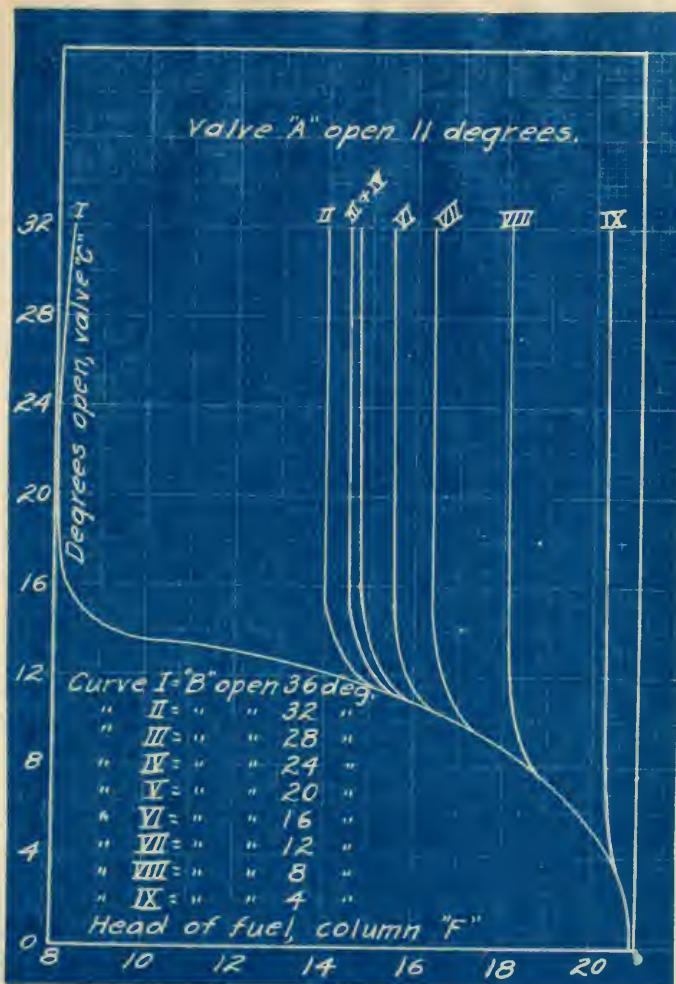


Fig. 10.



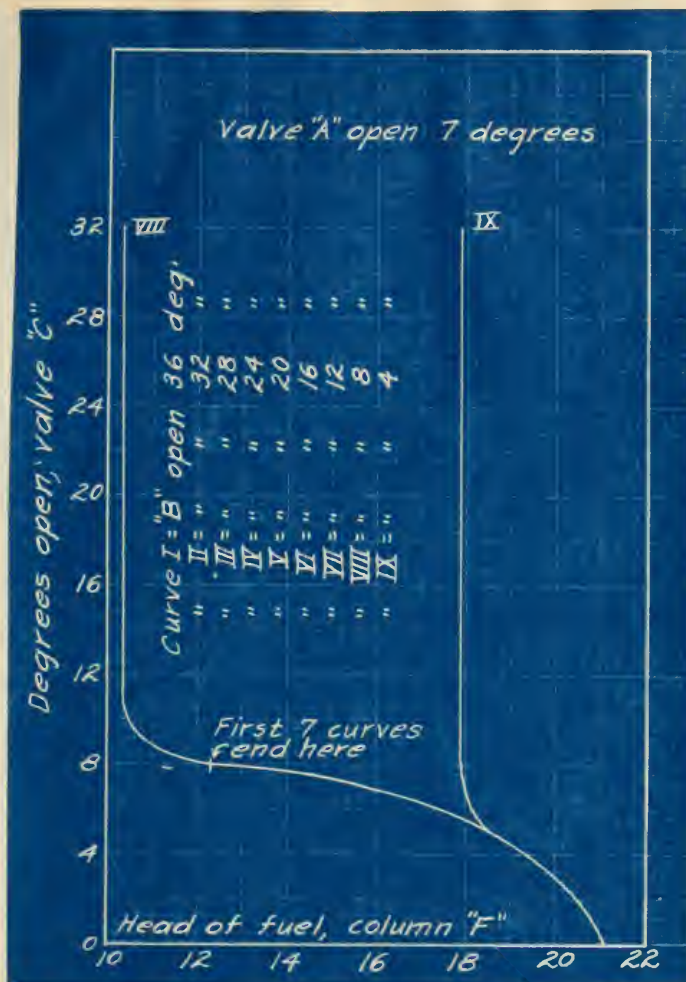


Fig. 11.



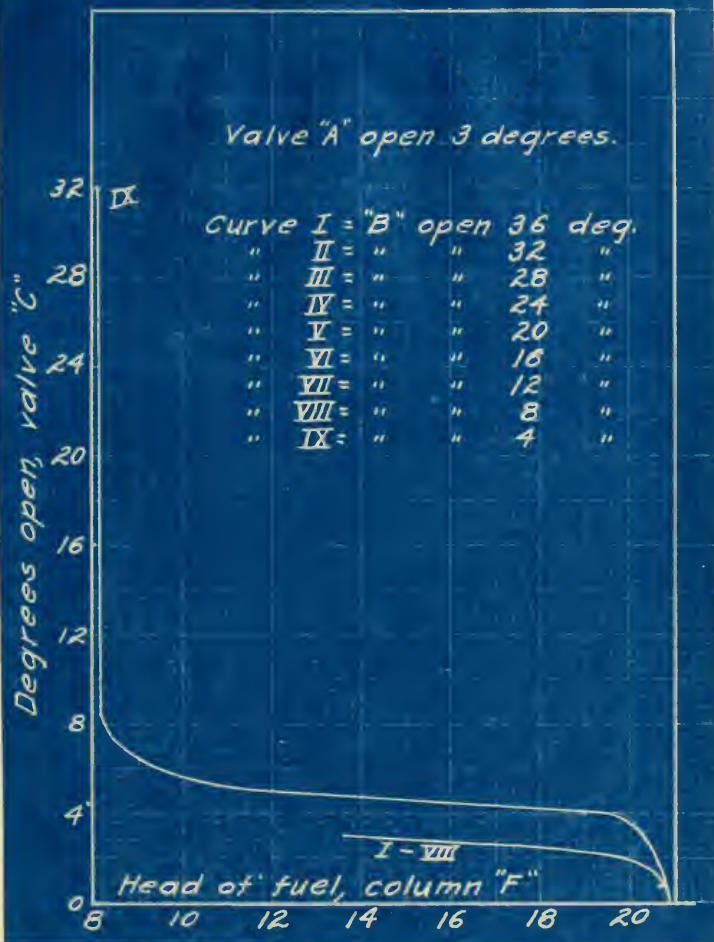


Fig. 12.



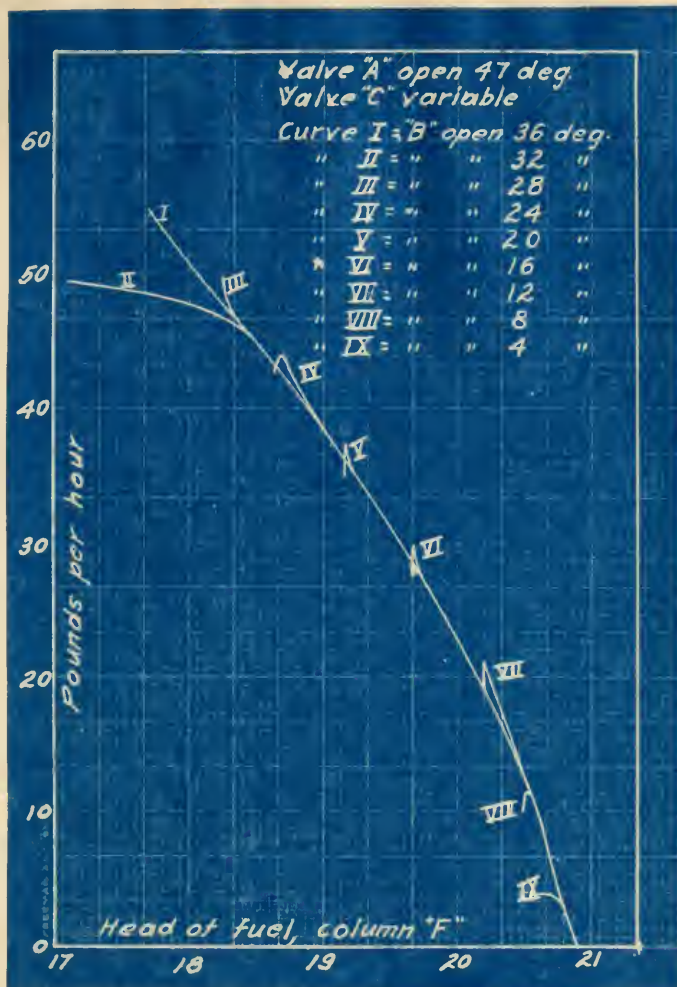


Fig. 13.





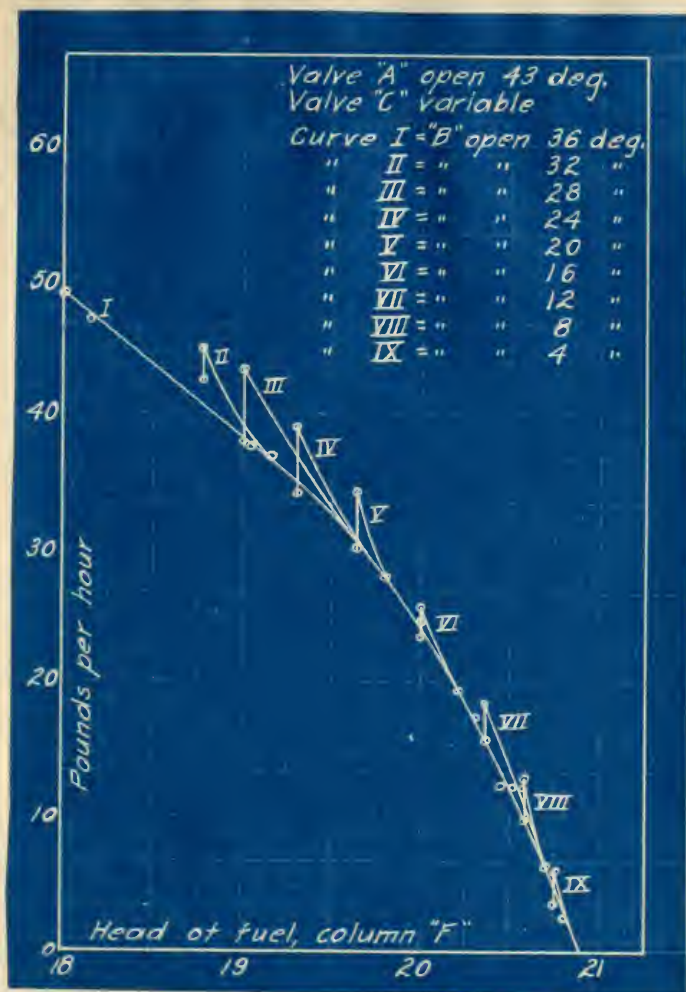


Fig. 14.



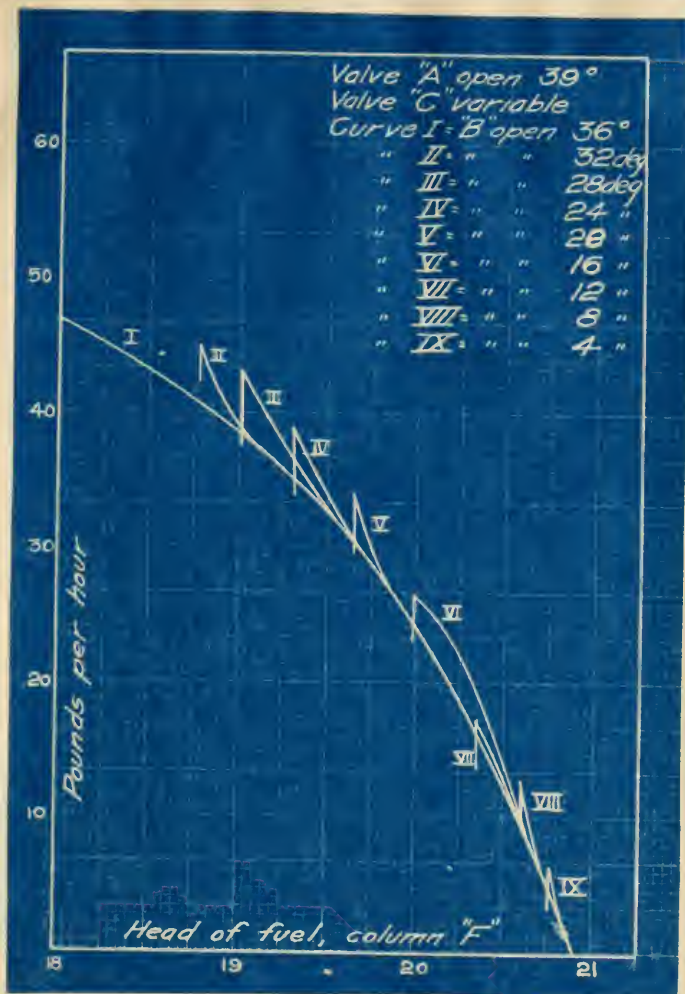


Fig. 15.



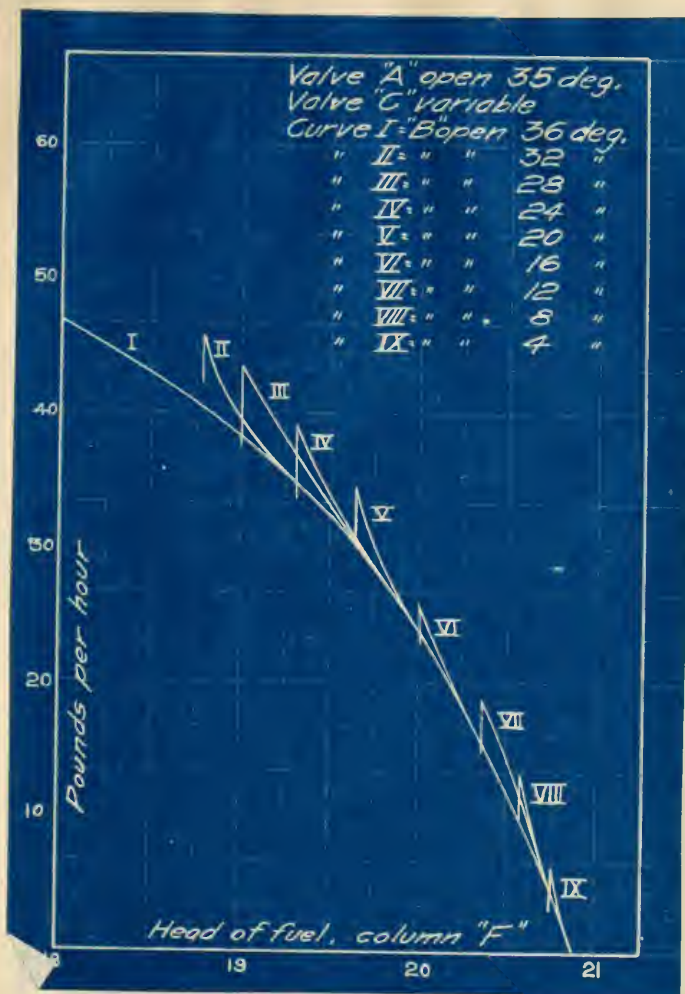


Fig. 16.



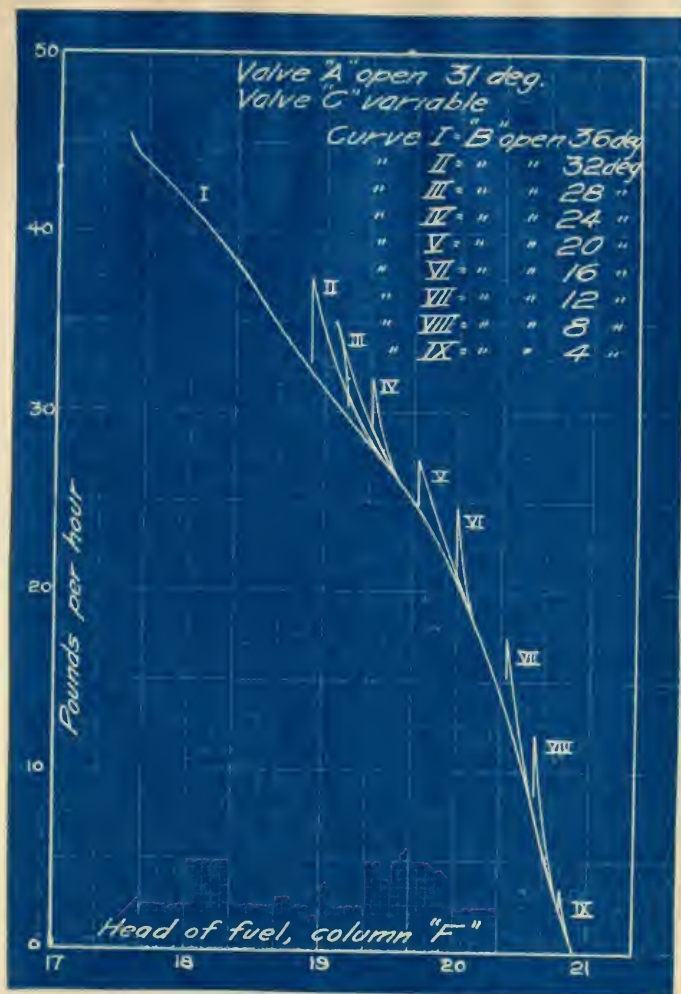


Fig. 17.





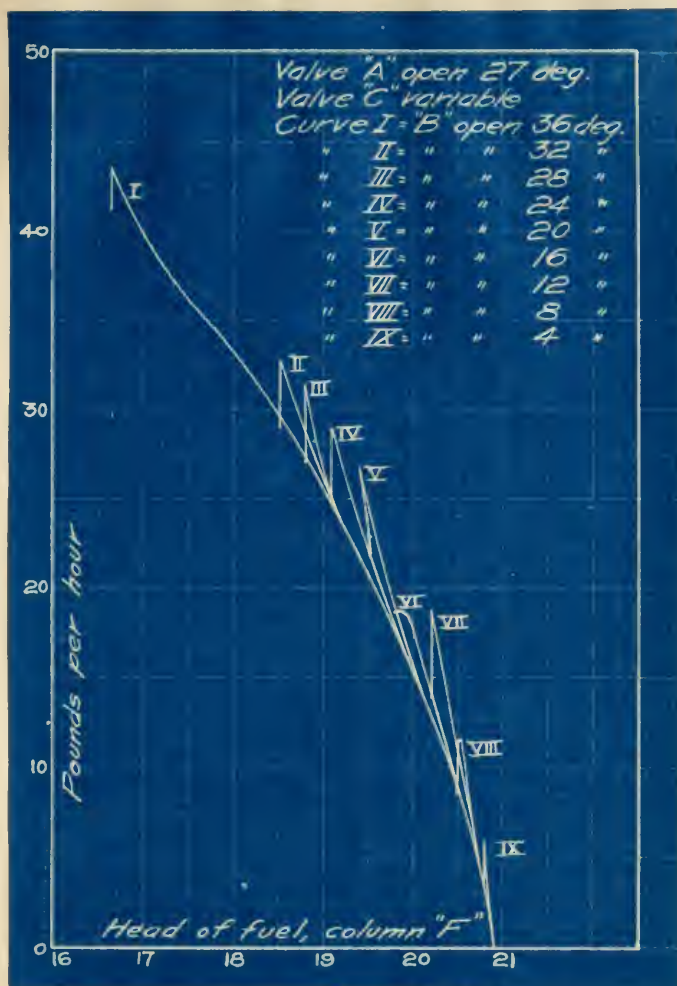


Fig. 18.



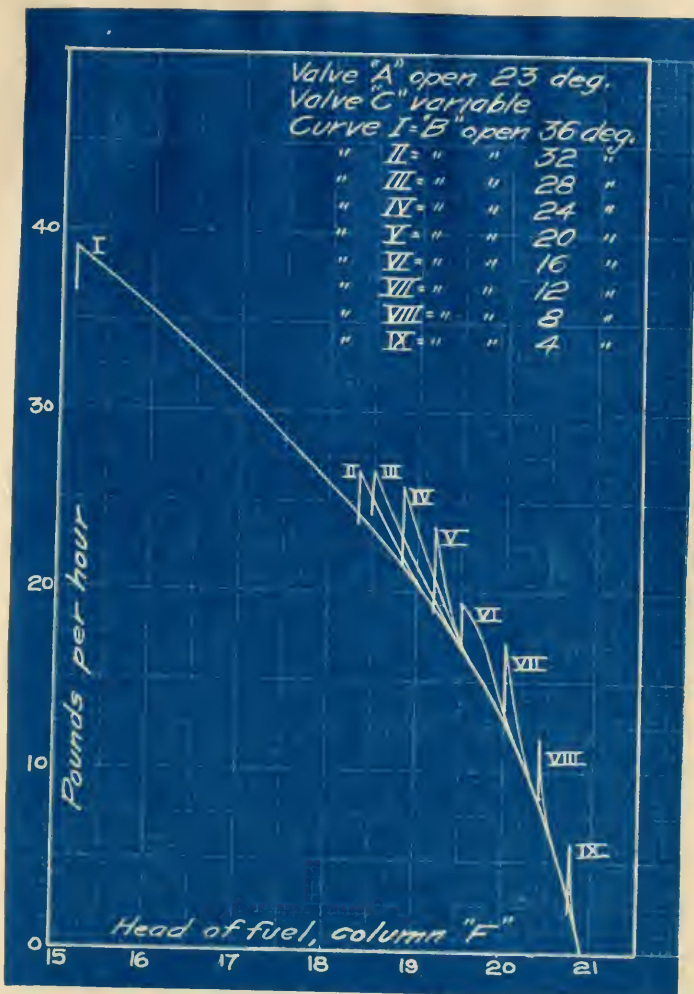


Fig. 19.



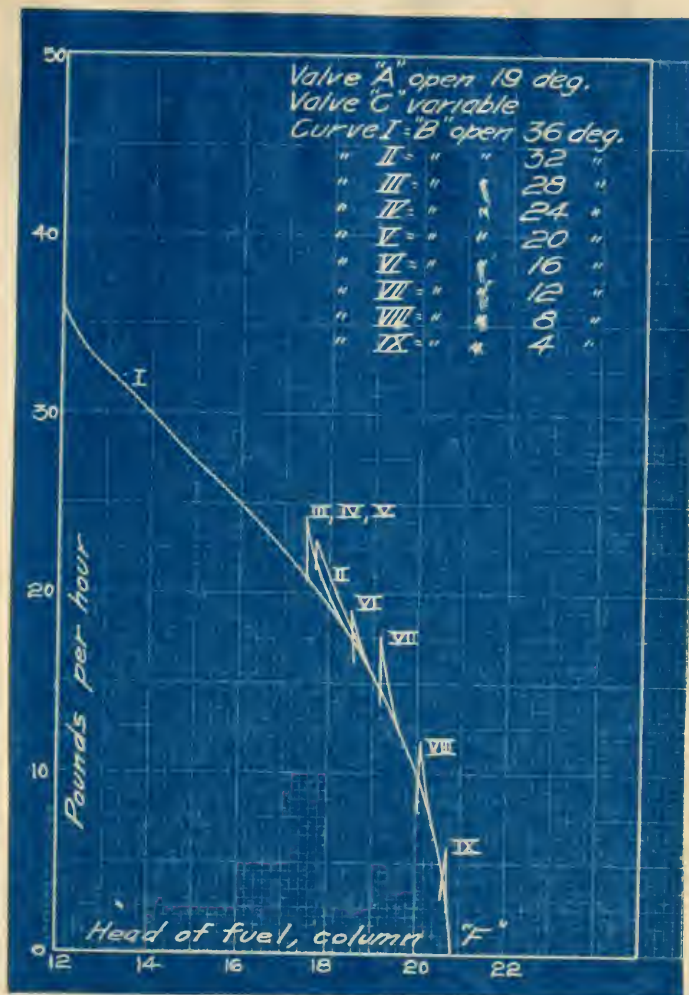


Fig. 20.



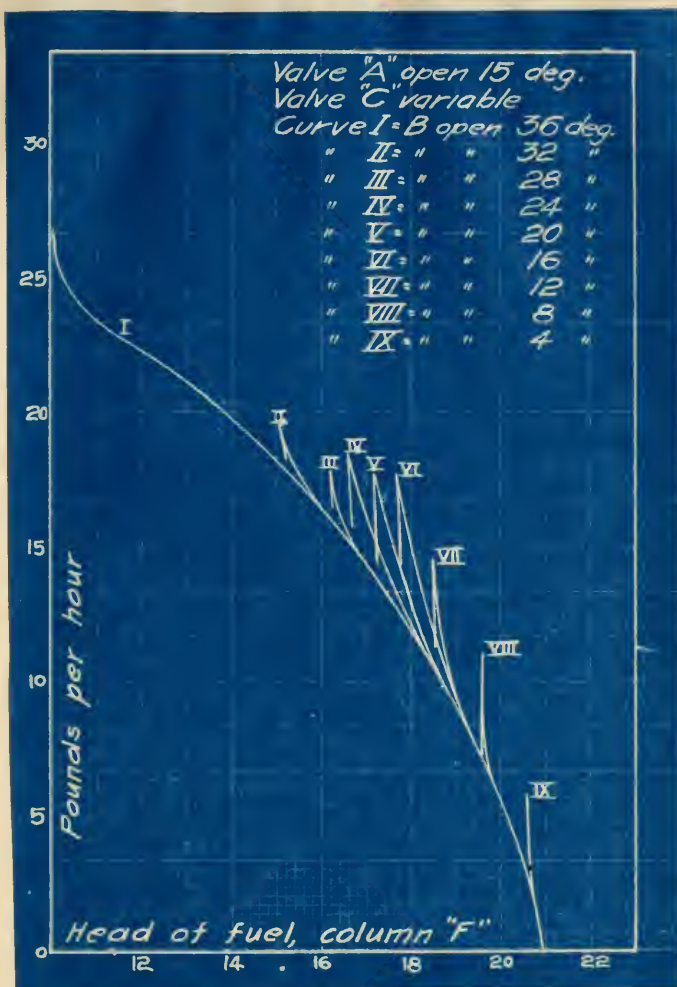


Fig. 21.





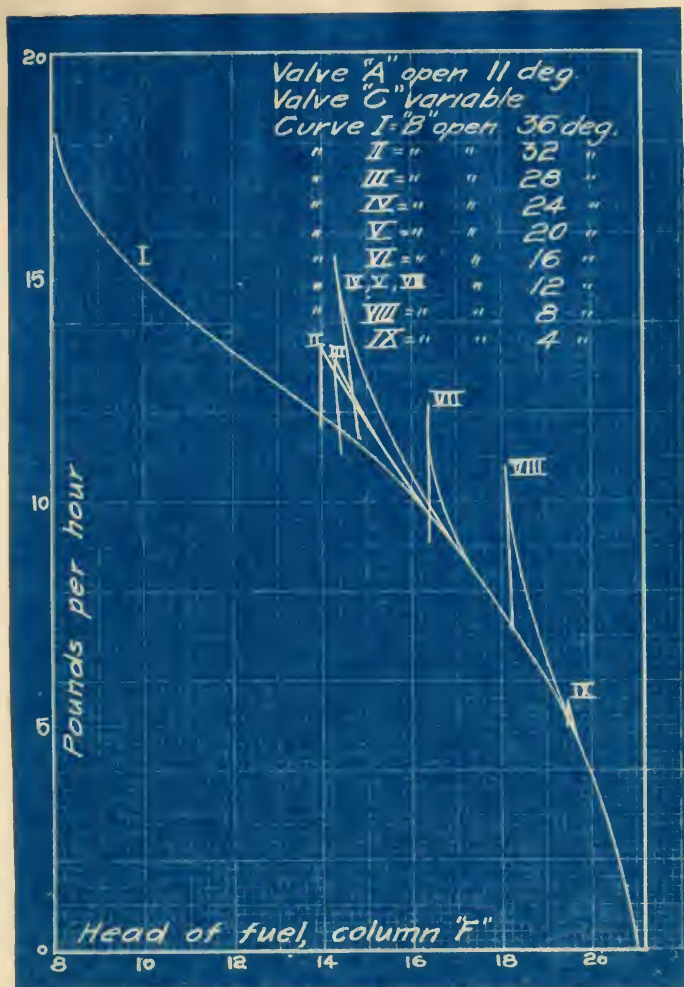


Fig. 22.



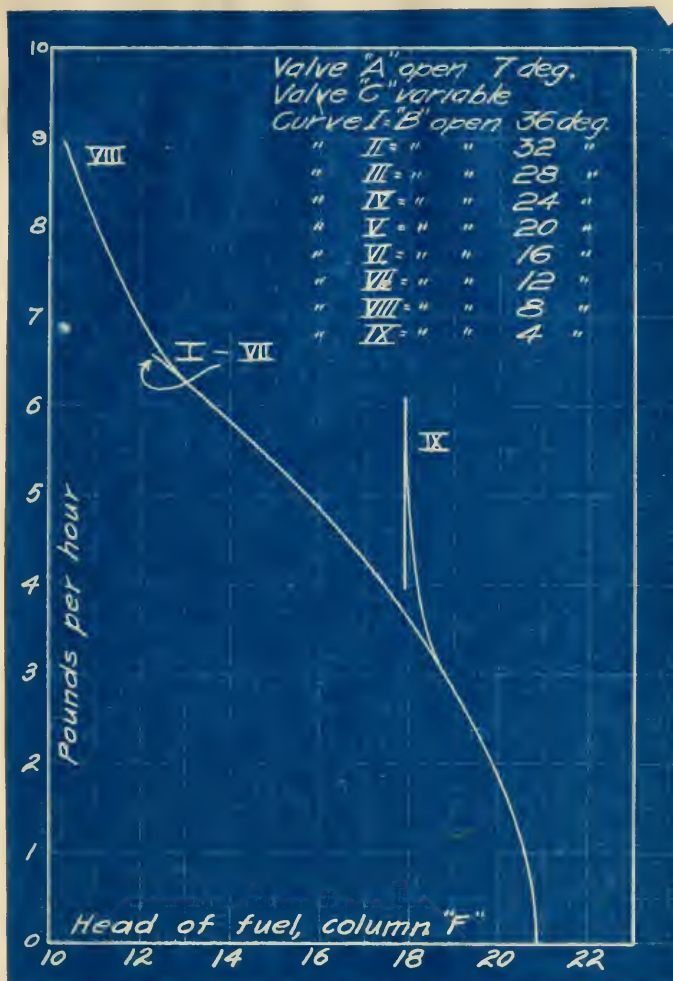


Fig. 23.



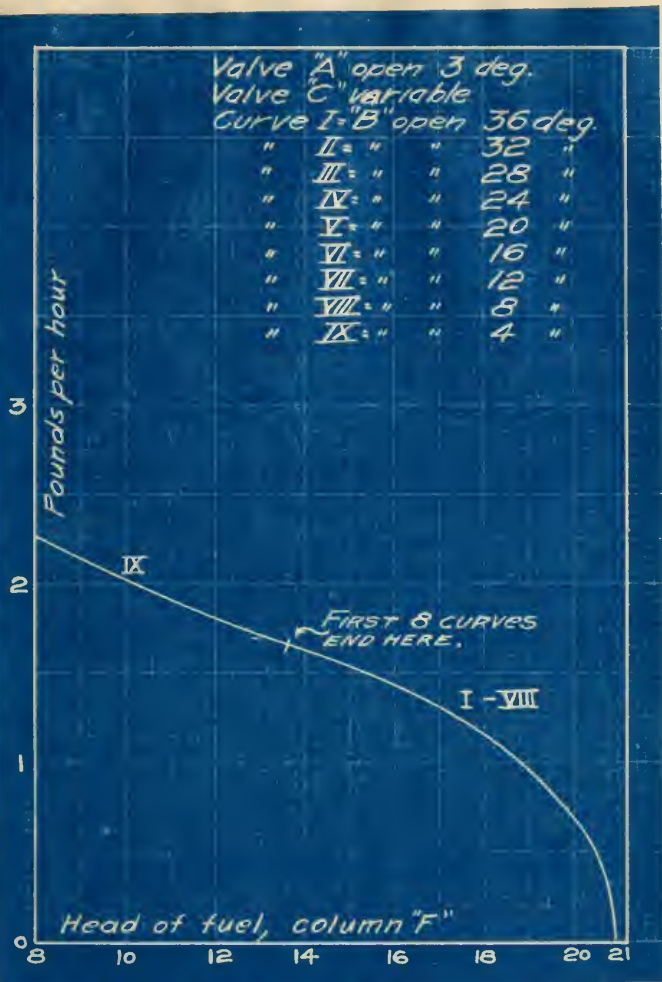


Fig. 24.



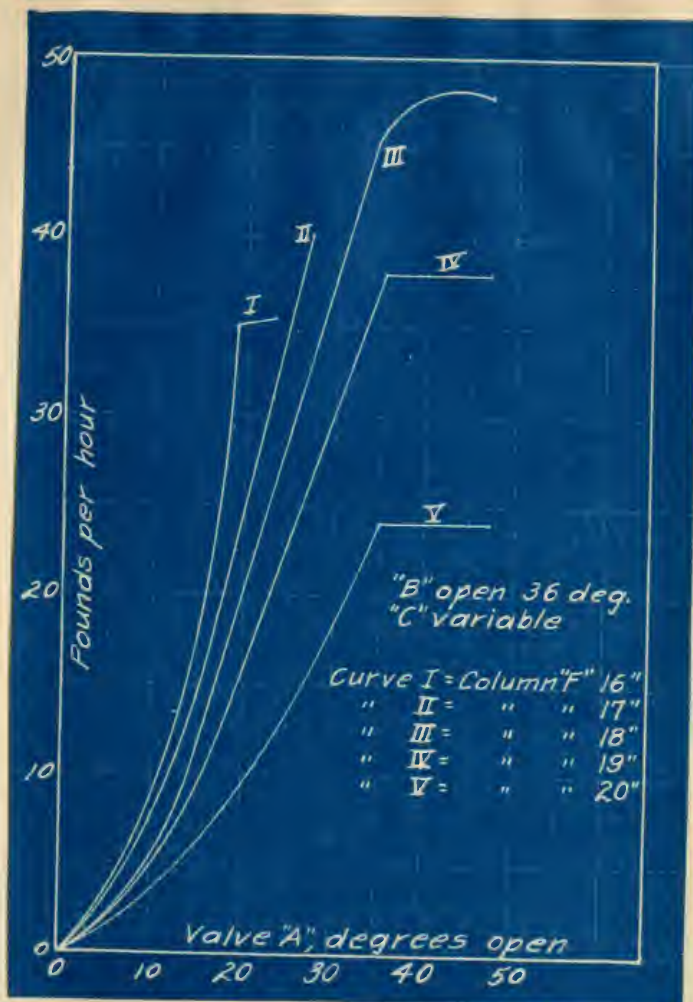
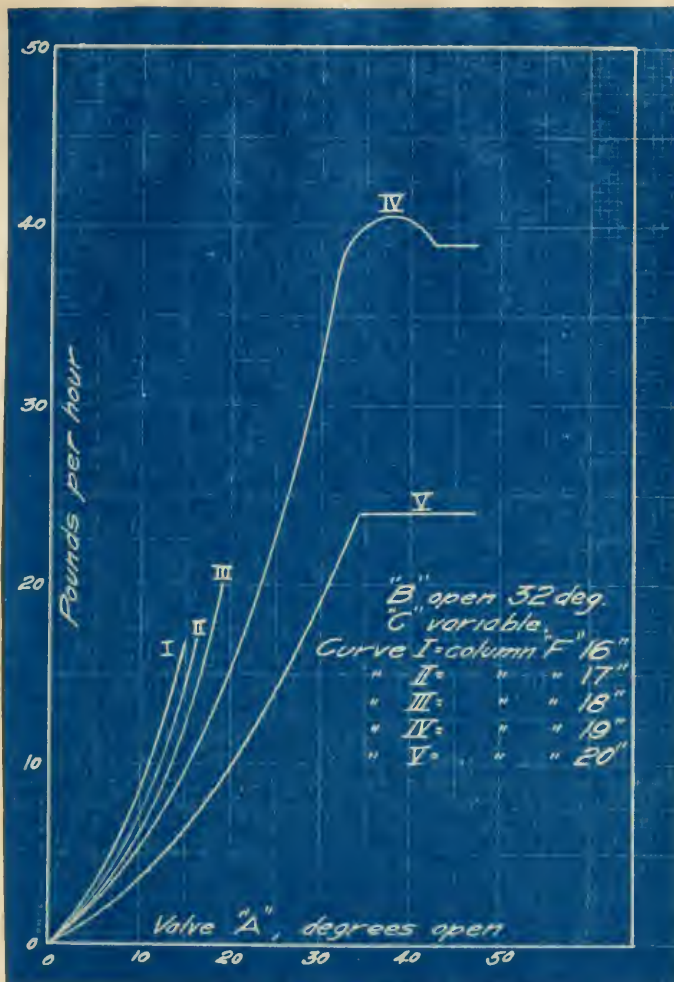


Fig. 25.







**Fig. 26.**



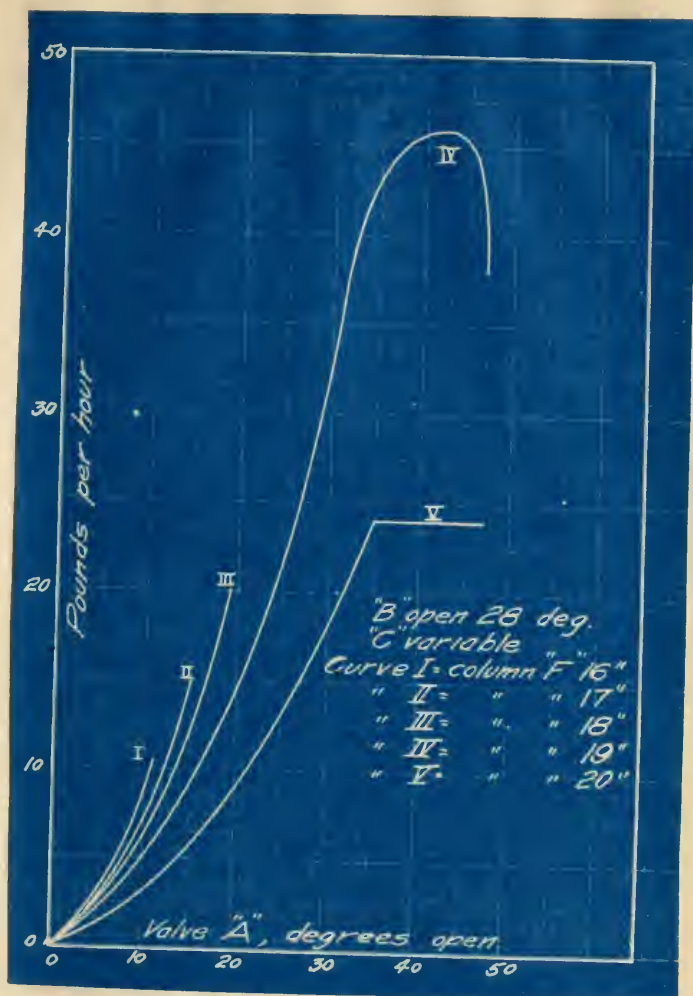


Fig. 27.



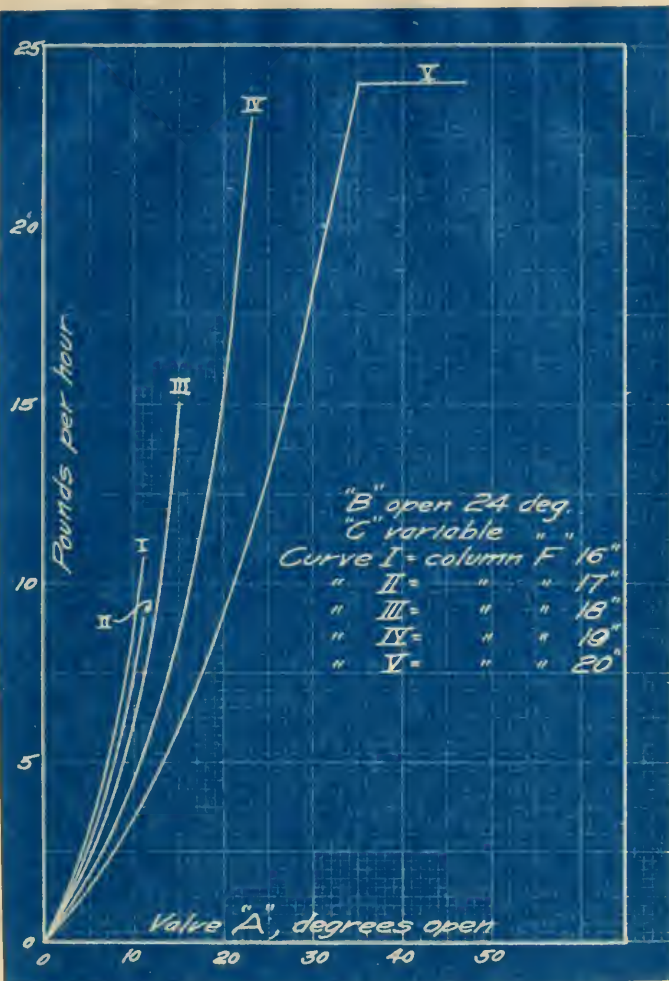


Fig. 28.



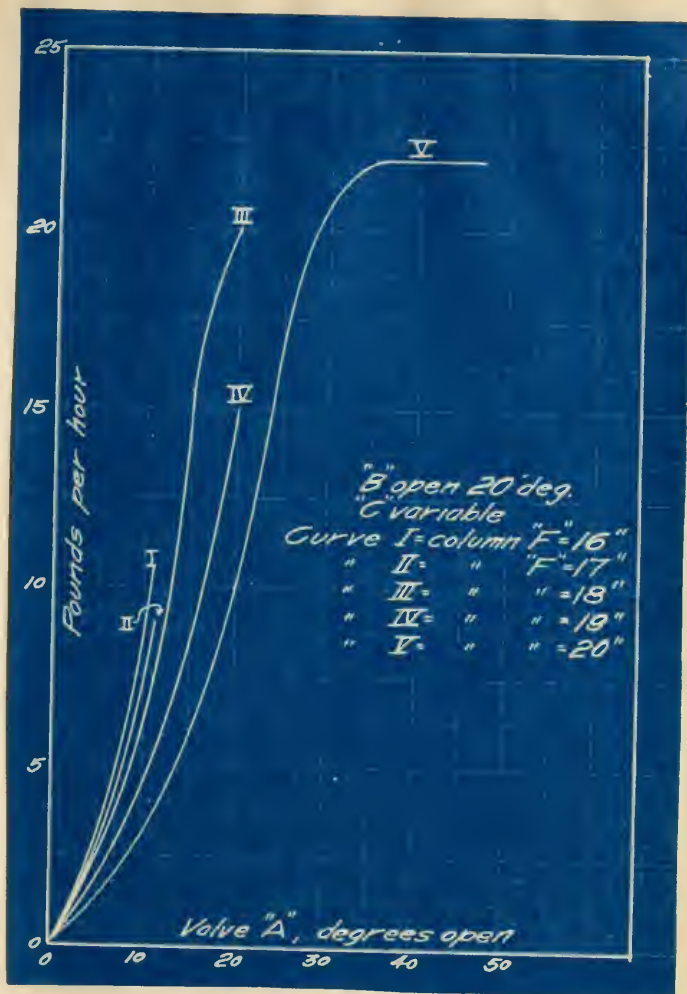


Fig. 29.





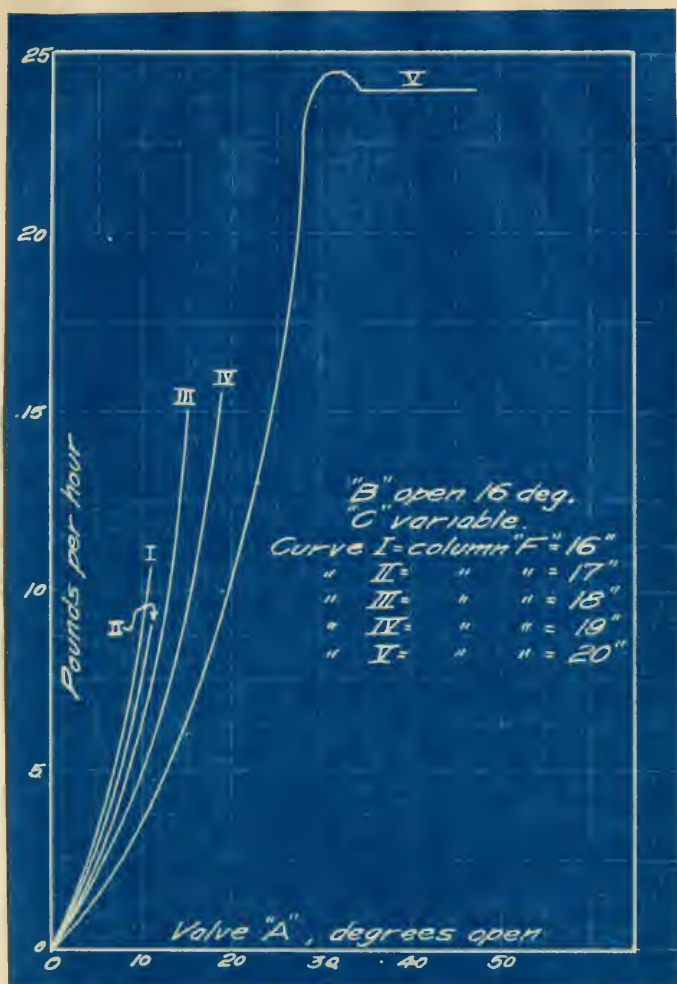


Fig. 30.



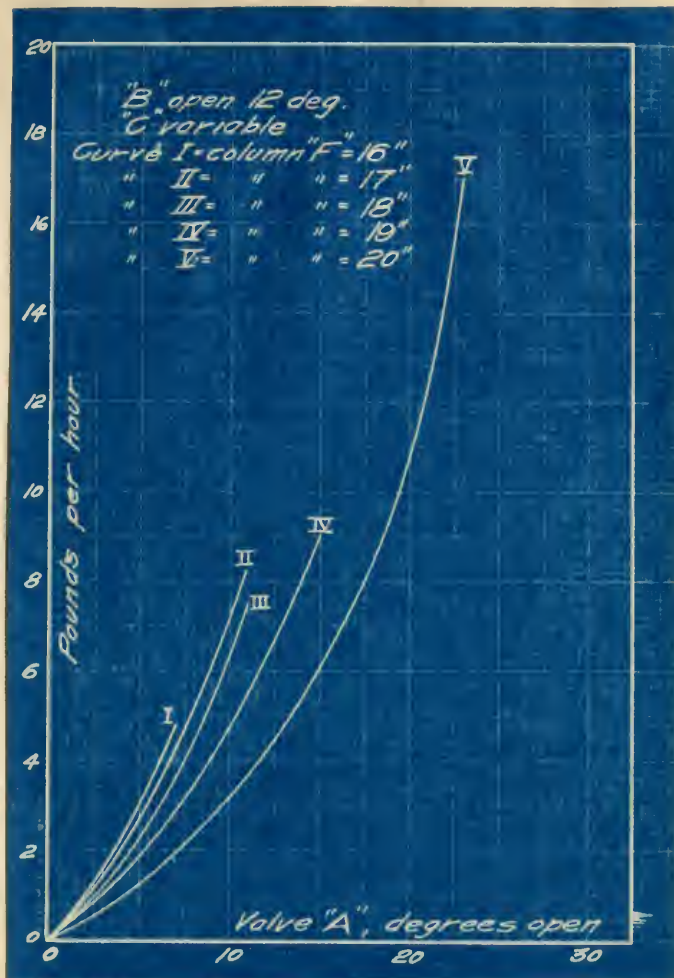


Fig. 31.



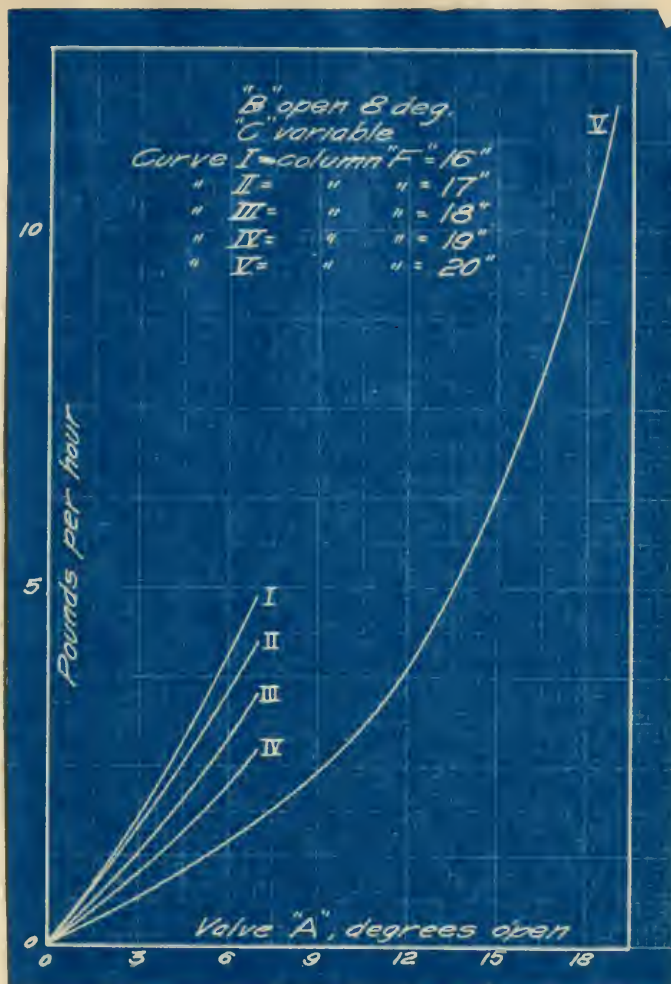


Fig. 32.



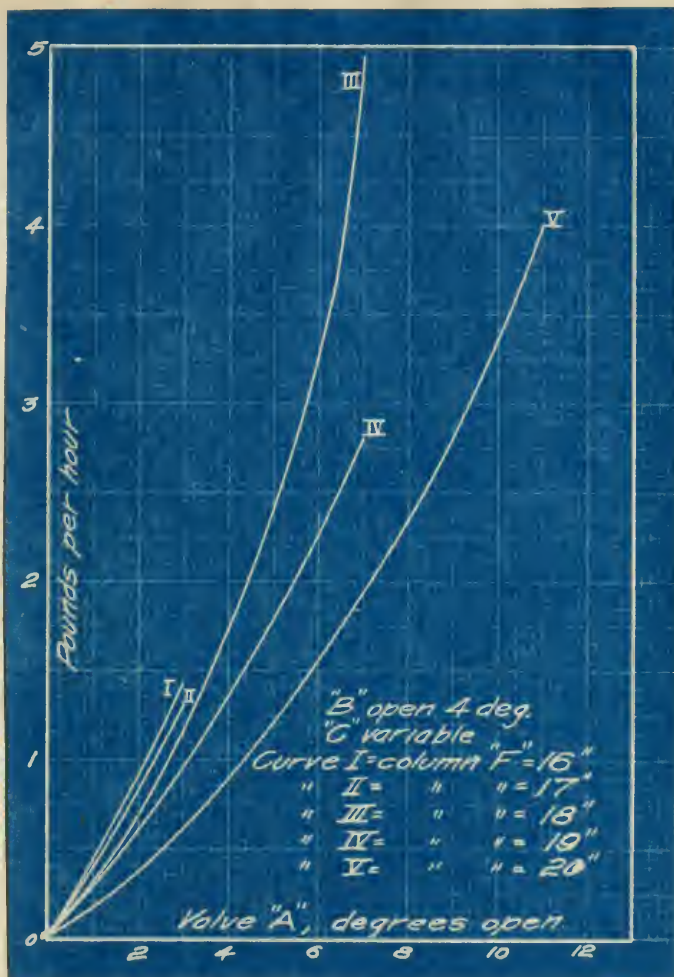


Fig. 33.





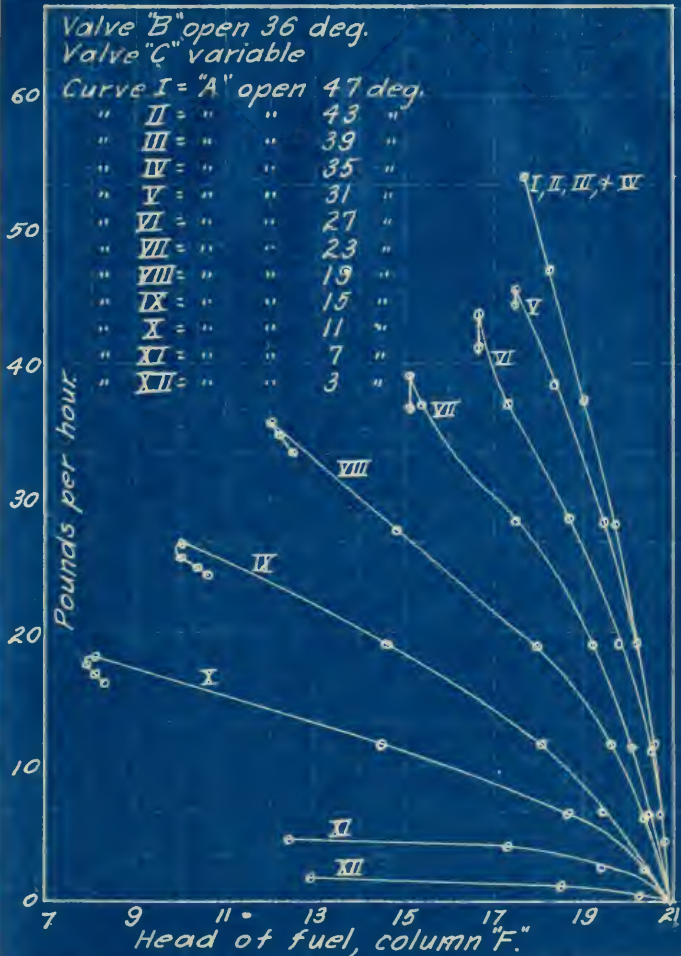


Fig. 34.



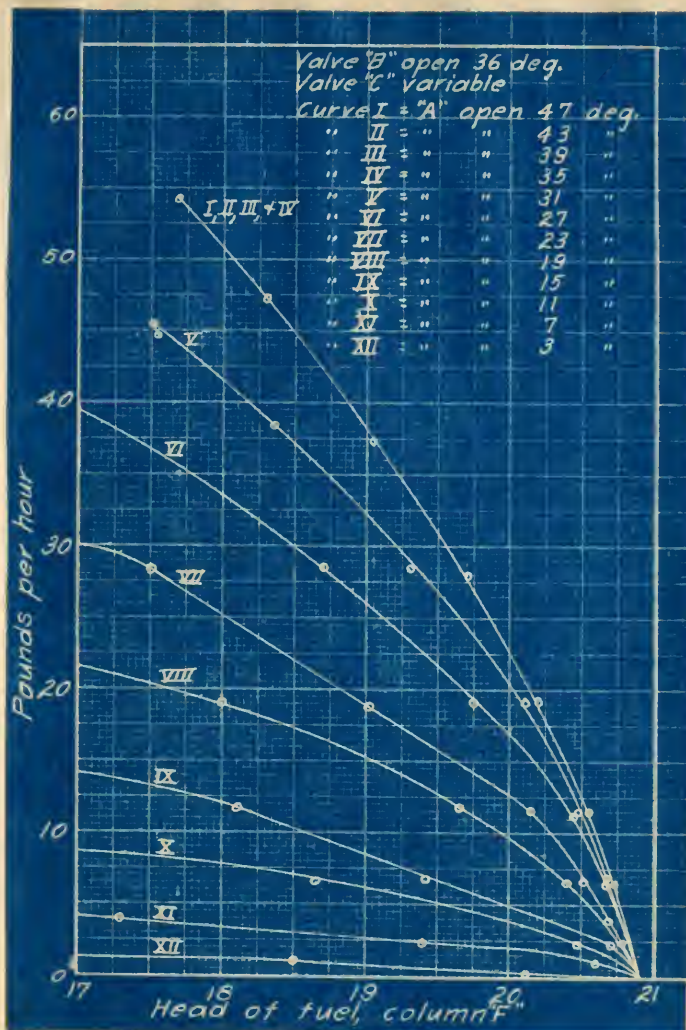


Fig. 35.



PART VII.  
Conclusion.



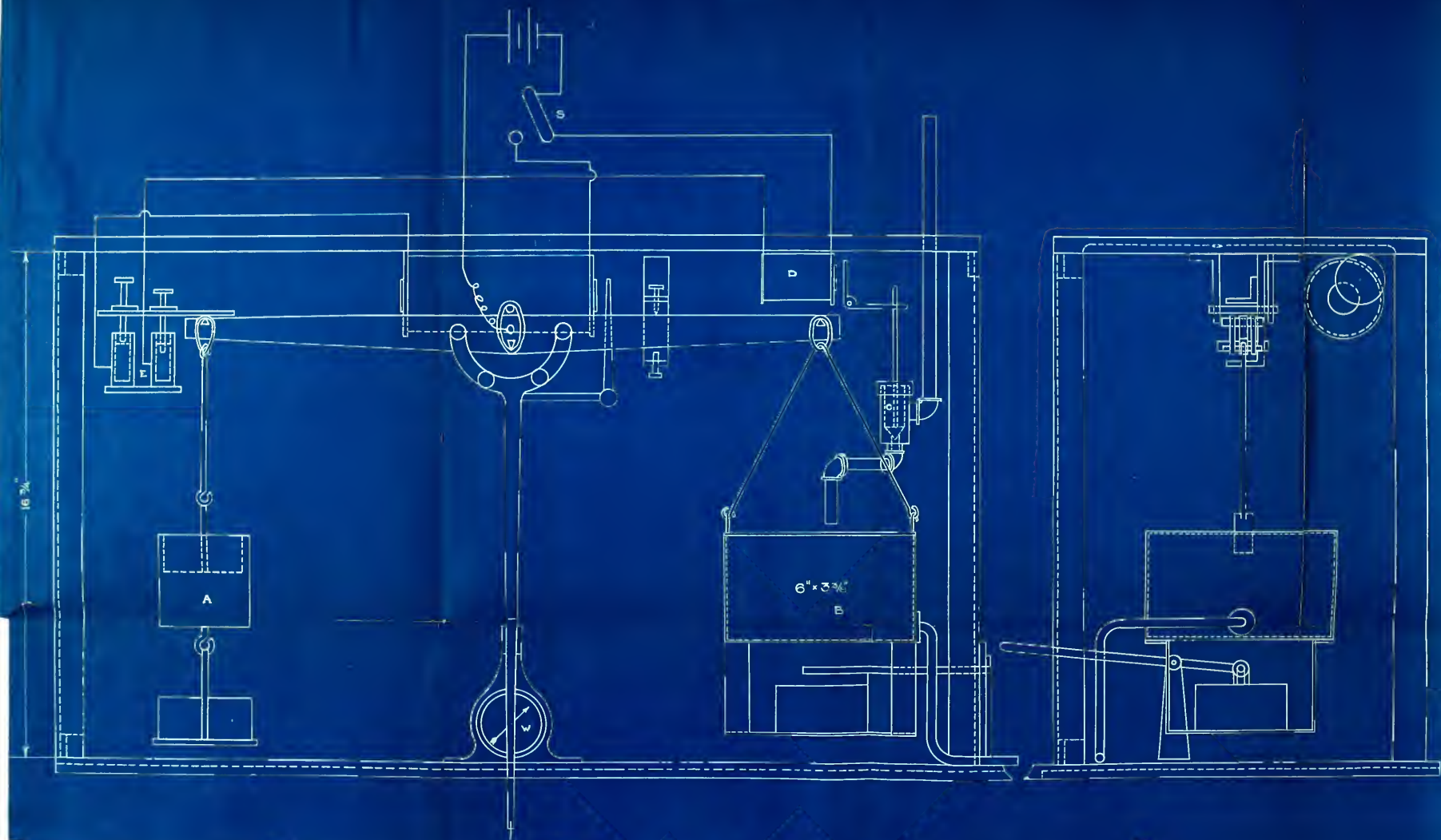
The preceeding data and curves show that and apparatus such as was used, can be used succesfully in determing the amount of oil which an engine is using at <sup>any</sup> instant, by referring to the proper curve as shown in Part VI..























T	29094	
q532.52		M34

Marks, Milton

Flow of liquid fuel through

929		orifices
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T	29094	
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